ENGINEERING

THE UNIVERSITY
OF MICHIGAN
DEC 7 1961
ENGINEERING
LIBRARY

arch:
erioration
lectrical Insulation

gn:
ing Aluminium
Flux Bath Brazing

uction:
rational Research
anagement's Need

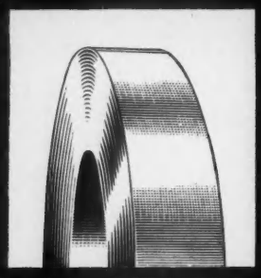
uct Profile:
BMC "Minis"

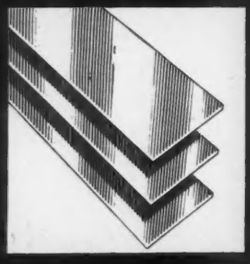
als and Materials:
l Castings
me Recent Examples

ial Article:
k and Travel
e Lands of Cold

"Sepia"

BARS

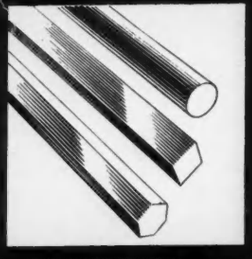




COLD ROLLED STRIP
MILD, HIGH CARBON
AND STAINLESS
STEEL

HIGH STRAIN AND
SPECIAL QUALITY
WIRES, ROUND AND
FLAT SECTION,
ALSO IN TRUBRITE
STAINLESS STEEL
QUALITY

BRIGHT STEEL BARS,
DRAWN, TURNED OR
PRECISION GROUND



ARTHUR
LEE
& SONS LTD

17 November 1961

Vol. 192 No. 4987

Founded in 1866

ENGINEERING

PUBLISHED EVERY FRIDAY

36 Bedford Street London WC2 England Telephone : Temple Bar 3663

Contents

634 Design

Joining Aluminium by Flux Bath Brazing

Tankers for Liquid Methane Create Design Problems, The Triostat: A Precision Regulator for Watches

Inter-service Unit for Hovercraft Trials, Precision Slip Ring Assemblies, High Efficiency Air Filters, Single Line Tracklayer, Suction Pyrometer for Accurate Temperature Measurement, Single Tank 132 kV Oil Circuit-Breaker

641 Construction

Tema Harbour and Township

First Nylon Nets on Multi-Storey Building, Portable Flyover to Relieve Traffic Blackspots, Use of Rubber in Road Surface Preparations

Extensions to Kings College, Newcastle, Third 2,000 MW Power Station for UK, Steelwork Framework for Church, Diary System for Civil Engineers, Progress at Arabian Gulf Tanker Terminal, Design of Precast Hollow Floor Units, London's Underground Garage in Hyde Park

646 New Plant and Equipment

Miniature Push-Button Switch, Calf-dozer Blade, Automatic Broacher, Marine Engine, Hand-Operated Spring Coiler, Two-Ton Dump Truck

Flame Failure Control Units, Centrifugal All-Purpose Pump, Hard Hat and Face Shield, Variable Transmission, Extraction Hose, Fire and Intruder Alarm.

Stabilized Power Supply Units, Excess Fuel Device, Lorry Crane, Tower Crane, Oscilloscope, Transistorized Tuning Device

650 Metals and Materials

Steel Castings—Some Recent Examples

Improved High Speed Steel, Porous Filters in Stainless Steel, Reinforced Plastic Foundry Patterns, Inflatable Raft in Coated Nylon, Nylon and Polyurethane Wheels

652 Production

Operational Research—Management's Need

661 Research

Research Report :

Deterioration of Electrical Insulation

Choosing a Research Reactor, Furnace Brazing in a Vacuum, Mechanical Properties of Foils

633 Impact

640 Human Element

649 Companies

657 Marketing

637 Automobile Review

Avoiding Fatigue Failure in Big Ends

644 Special Article

Work and Travel in the Lands of Cold

658 Product Profile

The BMC " Minis "

664 At Home

Pencils and Scissors

638 Plain Words

By Capricorn

638 Letters to the Editor

Completion of the Tamar Bridge
J. Farrell

The Teaching of Structures
J. H. Swannell

639 Events in Advance

654 Publications

On the Shelf
By Frank H. Smith

Books Reviewed :

Testing Time

The Private Car: Crompton Lanchester Lectures

High Fidelity Sound Engineering

Welding Handbook

Prestressed Concrete Cylindrical Tanks

Trade Publications and New Books

Cover Picture

During this year three similar 66,000 ton tankers have been built in British shipyards for the Shell Group. The second of them, the "Sepia," for Shell Tankers NV, Rotterdam, was built by Cammell Laird and is pictured here during trials on the Clyde

Subscription Rates: Editorial page 664 Index to Advertisers: Overleaf Appointments Advertisements: Face Editorial page 648

Advertisers in 'Engineering' this week

	PAGE
Adamson, J., & Co., Ltd.	15
Airscrew Co. & Jicwood, Ltd.	38
Allday, Wm., & Co., Ltd.	4
Alston Foundry Co., Ltd.	16
Amal, Ltd.	19
Andersons Insulation Co. Ltd.	76
Associated Electrical Industries, Ltd.	
Heavy Plant Division.	49
Transformer Division.	40
Automotive Products Co., Ltd.	36
B.T.R. Industries, Ltd.	83
Bailey, Sir W. H., & Co., Ltd.	4
Barry, Henry & Cook, Ltd.	15
Booth, Joseph, & Bros.	75
British Aero Components, Ltd.	42
British Electrical Development Association	45
British European Airways	48
British Hoist & Crane Co., Ltd.	28
British Steam Specialties, Ltd.	76
Broom & Wade, Ltd.	22 & 23
Butters Brothers & Co., Ltd.	84
CIBA (A.R.L.), Ltd.	14
Callow, F. E., (Engineers), Ltd.	35
Carobronze, Ltd.	15
Clayton-Wright, Howard, Ltd.	46
Clyde Crane & Booth, Ltd.	75
Clyde Crane & Eng'g. Co.	75
Cochran & Co., Annan, Ltd.	66
Colt Ventilation, Ltd.	25
Conveyor & Elevator Co. (1936) Ltd.	10
Cranes (Dereham), Ltd.	35
Crofts (Engineers) Ltd.	72
Curnon Eng'g. Co.	76
Dallow Lambert, Ltd.	80
Darlington Forge Ltd.	18
De Laval Ljungstrom Turbine Co.	58
Donkin, Bryan, Co., Ltd.	82
Eagle Pencil Company	68
Edwards, F. J., Ltd.	76
Eltron (London) Ltd.	10
"Engineering" Calendar	76
"Engineering" Quickbinde	81
English Electric Co., Ltd. Industrial Machines Department	54
Epsylon Industries, Ltd.	59
Fenter, Ltd.	81
Ferranti, Ltd.	67
Firth, Thos., & John Brown, Ltd.	55
Firth-Vickers Stainless Steels Ltd.	29
Flexible Ducting, Ltd.	68
Fry's Metal Foundries, Ltd. *Wrapper*	v
Fullerton, Hodgart & Barclay, Ltd.	48
General Descaling Co., Ltd.	37
General Electric Co., Ltd. of England	50
Godfrey, Sir G., & Partners (Ind.) Ltd.	64
Goulder, J., & Sons, Ltd.	15
Grafton Cranes, Ltd.	12
Gwynnes Pumps, Ltd.	11
Hackbridge & Hewittic Electric Co., Ltd.	81
Hall, J. & E., Ltd.	44
Harland Eng'g. Co., Ltd.	79
Heinke, C. E. & Co., Ltd.	78
High Duty Alloys, Ltd.	62
Hilmor, Ltd.	83
Hockley Foundry Co., Ltd.	19
Hoffmann Manufacturing Co., Ltd.	19
Hunt Heat Exchangers, Ltd.	2
Imperial Chemical Industries, Ltd.	
Fluon Division.	77
General Chemicals Division.	71
International Combustion Products Ltd.	34
International Meehanite Metal Co., Ltd.	75
KLM Royal Dutch Airlines	8
Keelavite Hydraulics, Ltd.	53
King Aircraft Corp'n.	76
Klinger, Richard, Ltd.	41
Lee, A., & Sons, Ltd. *Wrapper*	II
Lysaght-De Vilbiss Division of J. Lysaght's Ltd. *Wrapper*	VI
McNeil, C., Ltd.	6
Marconi Instruments Ltd.	63
Mavor & Coulson, Ltd.	74
Micanite & Insulators Co., Ltd.	30
Michell Bearings, Ltd.	15
Midland Silicones, Ltd.	9
Mills, James, Exors of, Ltd.	13
Mobil Oil Co., Ltd.	43
Morganite Carbon, Ltd.	32
Moss Gear Co., Ltd. *Wrapper*	VIII
Neal, R. H., & Co., Ltd. *Wrapper*	IV
Newall, A. P., & Co., Ltd.	73
Newbury Diesel Co., Ltd.	10
North British Rubber Co., Ltd.	24
Parks Forge, Ltd.	10
Parsons, C. A., & Co., Ltd.	51
Pegler & Louden, Ltd.	81
Philidas Division-Whitehouse Industries, Ltd.	56
Phosphor Bronze Co., Ltd.	42
Pickering Group of Companies	65
Power Petroleum Co., Ltd. *Wrapper*	VII
Pulsometer Pumps, Ltd.	33
Ransomes & Rapier, Ltd.	52
Ratcliffe, F. S. (Rochdale) Ltd.	33
Robson, G., & Co. (Conveyors) Ltd.	83
Rocol, Ltd.	60
Rose, Downs & Thompson, Ltd.	70
Scriven Machine Tools, Ltd.	19
Service Electric Co., Ltd.	
Sheffied Twist Drill & Steel Co., Ltd.	61
Slick Brands, Ltd.	12
South Durham Steel & Iron Co., Ltd.	69
Steele & Cowlishaw, Ltd.	6
Steels Engineering Installations, Ltd.	31
Stillite Products, Ltd.	46
Sulzer Bros. (London), Ltd.	7
Tangyes Ltd.	20 & 21
Taylor, B. & R.	8
Taylor Industrial Clutches.	30
Tecalemit (Engineering), Ltd.	47
Teddington Aircraft Controls, Ltd.	17
Teddington Autocontrols Ltd.	59
Tedson, Thornley & Co., Ltd.	79
Timber Development Association, Ltd.	57
Tonks, J. & Co., Ltd.	15
Town, F., & Sons, Ltd.	39
Unbrako Socket Screw Co., Ltd.	10
Unicone Co., Ltd.	33
Vandervell Products, Ltd.	20 & 21
Vulcan Boiler & General Insurance Co., Ltd.	79
Weir, G. & J., Ltd. *Wrapper*	III
Wellman Bibby Co., Ltd.	80
Wellman Smith Owen Eng'g. Corpn., Ltd.	26
Welsh Metal Industries Ltd.	5
Whittaker Hall & Co. (1929), Ltd.	12

'Engineering' Appointments Section inside Editorial Section

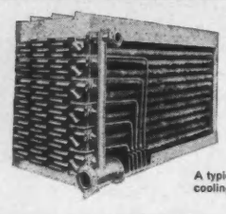
A/S Atlas	4
Lucas, Joseph, Ltd.	3
Parsons & Marine Engineering Turbine Research and Development Association	3
South Australia, Government of,	3
Thermalite Ytong, Ltd.	3
Trinoll (U.K.) Ltd.	3

Classified: Trade & Technical

Bell, H. (Machine Tools) Ltd.	3
City Sale & Exchange, Ltd.	3
College of Aeronautics	3
Edwards, F. J., Ltd.	3
Government Surplus Stores	3
India Store Dept.	3
K.E.N.T. Machinery & Engineering Co.	3
Kerrier, Rural District Council	3
Marks & Clerk	3
Norris Bros., Ltd.	3
Plint & Partners, Ltd.	3
Research Engineers, Ltd.	3
Ward, Thos. W., Ltd.	3

Sales and Valuations

Butcher, Henry, & Co.	2
Farmer, Leopold, & Sons	2
Fuller Horsey Sons & Cassell	2
Goddard & Smith	2
Knight Frank & Rutley	2



A typical cooling unit

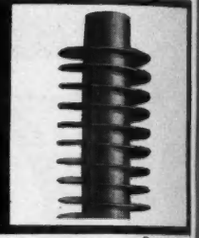
EXTENDED SURFACE HEAT EXCHANGERS

NOW available with FLAT FINS

For heaters and coolers

Write for full details Ref. EC/11 HUNT HEAT EXCHANGERS LIMITED MIDDLETON MANCHESTER Tel: Middleton 2243

London Office:— Temple Chambers, Temple Avenue, E.C.4 Tel: Ludgate Circus 7796/7



SALES AND VALUATIONS

FULLER HORSEY
SONS & CASSELL

Industrial Valuers
Surveyors
Auctioneers
and
Estate Agents
since 1807

10 LLOYD'S AVENUE,
LONDON, E.C.3
ROYAL 4861 G 3

SALES AND VALUATIONS

Knight
Frank &
Rutley

Industrial Surveyors

20 Hanover Square
London W.1
MAYfair 3771. (20 lines)
G5

TRADE AND TECHNICAL

SALES AND VALUATIONS

LEOPOLD
FARMER & SONS

conduct

AUCTION SALES
and
VALUATIONS

OF PLANT, MACHINERY AND INDUSTRIAL PROPERTIES

46 GRESHAM STREET,
LONDON, E.C.2.

Telephone: MONarch 3422 (10 lines)
Telegrams: Sites, London
G 6

PLINT & PARTNERS LTD.
Blakes Road, Wargrave, Berks.
Tel: Wargrave 427
MECHANICAL ENGINEERS
Investigate research problems and design and manufacture equipment for
RESEARCH & DEVELOPMENT
INSTRUCTION G 778

EXPERIMENTAL
DEVELOPMENT WORK
PROTOTYPES

SPECIAL PURPOSE MACHINES
PRECISION ENGINEERING FROM SMALL SCIENTIFIC INSTRUMENTS TO MACHINES AND APPARATUS OF SEVERAL TONS
A.I.D. AND A.R.B. APPROVED

RESEARCH ENGINEERS LIMITED
ORSMAN ROAD, SHOREDITCH, N.1.
SHO 7811/7815 G 900

HENRY BUTCHER
and Co.
Auctioneers, Valuers
and Surveyors

Specialising
in the
SALE & VALUATION
of
Engineering & Allied Works
Plant & Machinery
FACTORY AGENTS

73 CHANCERY LANE,
LONDON, W.C.2.
HOLBORN 8411 (8 LINES)
G 4

GODDARD & SMITH

For the
Sale & Valuation
of all types of
Industrial Premises
Plant & Machinery

GODDARD & SMITH

22 King Street

St. James's, S.W.1.

Tel: WHI 2721
(20 lines) G 1

INDUSTRIAL
MODEL CONTRACTORS

NORRIS BROS. LTD.
53 VICTORIA ST., LONDON, S.W.1
Tel: ABBey 6132
and at Burgess Hill, Sussex
Specialists in
RESEARCH, DESIGN
AND DEVELOPMENT
throughout the whole Engineering Industry
G 900

WORK WANTED

MECH/ELEC ENGINEERS, GLASGOW CENTRE, wish Service/Maintenance Installation work from machinery maker in South with sales but no Scottish Depot. Can also provide separate office and storage 1,500 sq. ft. —Write 10N4, WM. PORTEOUS & CO. GLASGOW. H 651

ENGINEERING Impact

of the Public Voice of Professional Engineers

It is almost unbelievable that professional engineers in Britain are not represented by an organization which can speak for them on matters of common and public interest. To be precise, there is no suitable organization which commands a majority support from the members of the profession, for the Engineers' Guild enjoy the appropriate terms of reference but lack an adequate membership. How has this situation arisen? And why is there now a growing awareness of the vacuum?

The growing awareness is partly due to the emphasis which has been placed on science, especially since the Second World War. The importance of scientific research had to be rammed home in Britain because although the value of basic and applied science had been amply demonstrated during the war, the lesson had not been learned properly by many who should have known better—from the Government to school teachers, including the trade unions, large slices of industry, and Civil Servants. Some are still not converted. Meanwhile, the importance of engineering has inevitably been overlooked. A new campaign needs to be waged—that if we want a prosperous future we must engineer it.

Engineers themselves are thus becoming conscious of the need to shift the emphasis. Unfortunately, their own institutions have become so science-minded, no one seems to know how to put over the importance of engineering.

Britain's interest in the Common Market is adding to the new awareness, because the questions that arise are down-to-earth engineering questions, not academic scientific discussions. And Sir George McNaughton's recent presidential address to the Institution of Civil Engineers brought out the need for a single representative body to a wider audience. He supported the suggestion that a high level co-ordinating board should be established to speak for the three major institutions on all matters of public interest and policy.

The Unheard Voices of Specialist Institutions

Ever since the Institution of Mechanical Engineers was founded in 1847, thus providing a specialist forum separate from that of the older Institution of Civil Engineers, there has been a multiplication of specialist institutions. That development is now often regretted, but it was and is inevitable. There are very few general practitioners in engineering: an insistence at Cambridge and elsewhere on a broad education for an engineer is followed, for the individual, by a necessary specializing once he goes into industry.

This weakening of the corporate spirit of the profession by the growth of institutions has been aided by the role which the institutions have chosen for themselves. They have chosen to be qualifying bodies, conferring a status on the individual who bears their letters after his name. And as tests of academic knowledge are the only certain way of testing anyone for eligibility, the theory of engineering has been elevated at the expense of the less easily measured but equally vital practice of engineering. The desire of some of the institutions to avoid or reduce the burden of paying rates, by asking to be considered as coming under the provisions of the Scientific Societies Act, gave a further push in the same direction.

The idea which the President of the Civils supports—of a high level co-ordinating board for the three major institutions—runs into opposition from some of the lesser institutions.

Would such a board adequately "speak on all matters of public interest and policy?" Since few of the separate institutions have been noticeably active in speaking even on behalf of their specialist interests, the new board would have to be an entirely new concept if it were to fulfil the hopes placed in it.

Whatever plan is eventually adopted, informed interest and opinion have yet to be mobilised in the profession as a whole. The institutions have the requisite membership, but are at present too limited in their activites. The Engineers' Guild engage in the needed activities (e.g. their conference last March and their plan for an overseas technical service) but they lack the membership.

No one can see the way out of this dilemma clearly. But the time seems to have arrived when there are enough engineers with the will to find a way out.

Government's Eye on Research

Behind the Government's decision not to go ahead at present with the building of a nuclear-powered merchant ship may be something of wider significance, indicating an impending change of policy regarding Government sponsored research.

Their decision over the ship was qualified by saying that they have decided the right course in present circumstances is to authorize a vigorous programme of research aimed at a reactor system which is economically attractive to a wide range of shipping. This research will be carried out by the Atomic Energy Authority in conjunction with industry.

The Minister for Science recently said that "no one can produce a successful outcome to an investigation just by giving orders and spending money. If one knew which investigations were likely to prove successful, or how much money it was desirable to spend on them, it would be because one already knew, at least in principle, the answers." The best the Government could do in commissioning research was to support first class people and promising ideas and refuse to support the bogus and second rate.

The Government, it seems, intend to have more control over the way they put money into scientific and engineering research. The Committee on Management of Research have already submitted their report to the Government, but it will not be published for some time.

Russia has the icebreaker "Lenin" and America the cargo-passenger ship "Savannah," but these ships are largely floating test-beds; their reactor systems are not economic in the commercial sense.

But nuclear propulsion deserves Government support, and the decision to proceed with research into the best reactor system rather than spend money on an uneconomic ship now is a wise compromise. It is a pity, however, that research is to commence after five consortia have spent time and money in tendering.

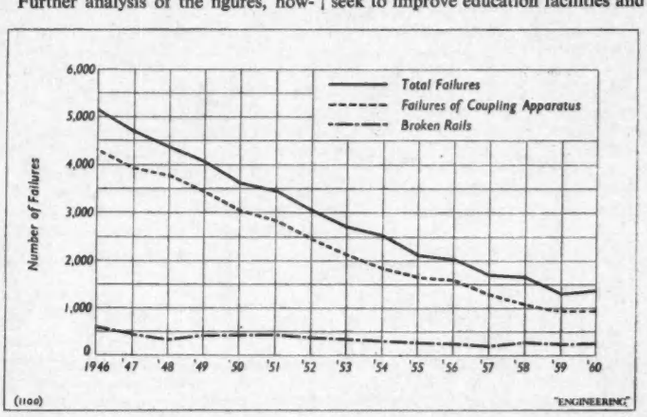
the Railways Becoming Still Safer

There has been a steady fall for many years in the annual total of failures of equipment on the railways, as shown in the accompanying graph, which refers to all kinds of breakdowns of both rolling stock and the permanent way. In his annual report *Railway Accidents During 1960* (H.M. Stationery Office, 6*s* 6*d*), Brigadier C. A. Langley, the Ministry of Transport's chief inspecting officer of railways, observes that the graph shows, for 1960, what appears at first sight to be a significant reversal (except as regards couplings) in the improvement that has been apparent continuously since the war. The very large proportion of mechanical breakdowns that are due to coupling failures—and the increase in their reliability that there has been since 1946—is clearly demonstrated by the graph.

Further analysis of the figures, however, shows that the increase in 1960 was wholly accounted for by a considerable increase in the number of broken rails over the previous year and a very big increase in the figure for flooding of the permanent way and slips in cuttings. This latter increase, Brigadier Langley points out, was itself largely the result of the exceptionally bad weather during the second half of the year; and, he adds, heavy rain also played its part in the increase in the failures of tunnels, bridges and viaducts.

Of broken rails, the report shows that the figure of 238 failures was 28 per cent higher than for 1959. Though well below the 1958 total, the figure was somewhat higher than the average for the past five years, the increase being proportionately greater with bull-headed than with flat-bottomed rails. Though Brigadier Langley does not say so, the larger number of broken rails may also be attributed to the bad weather and consequent weakening of the sub-grades below the ballast.

Passenger safety is extraordinarily high. The report says there is but one chance in 50 million journeys of a passenger's death in a train accident. All-steel coaches, the automatic warning system and colour light signals have helped significantly to increase safety. But unfortunately accidents from human failings have been rising—there were 37 per cent more such incidents in 1960 than in 1946. Is this the almost inevitable result of installing "fool-proof" devices? It becomes more difficult for operators to maintain their vigilance until the moment when human control must take over from automatic control.



Safety on the railways: engineering's contribution in the past 15 years.

and Reprography: The Technology of Copying

On Thursday, 23 November, a new institute is to be launched—the Institute of Reprographic Technology. It will be concerned with the technology of reproduction in relation to graphic arts.

Methods of reproduction of the written or printed word are now legion, and the quality of the result is almost as variable. The majority depend on some type of photographic technique and the number of persons engaged in the art must be large. The formation of an institute with entrance by examination immediately raises the status of those concerned.

Apart from providing a forum and professional status, the institute will seek to improve education facilities and to encourage research and development to improve the efficiency of reprographic services. The syllabus for the final examination includes such headings as office duplicating, light sources, photography, dyeline and allied processes, office documentation (including microfilms), printing, and typewriting. The coverage is wide.

There is undoubtedly a place for "reprography," but the use of the process should not be carried too far. Many documents have to be reproduced from one original, but photocopying is still an expensive business. In spite of the expense, it is frequent practice to photograph pages from a journal—even from a current number—when it would be far cheaper and often quicker to buy another copy of the original. Copies even of back numbers are usually available and can be ordered by telephone at a cost of a shilling or two, which is less than the cost of photocopying a single page.

Joining Aluminium by Flux Bath Brazing

Aluminium flux bath brazing is especially valuable for the joining of light gauge metals where inaccessible joints are required and where distortion must be kept to a minimum.

ALUMINIUM and its alloys are often disregarded by designers because of limited knowledge of the methods by which they can be joined. Flux bath brazing has been developed in this country and offers consistency of joint whether of a simple or complex nature. To help in their own heat exchanger production, Delaney Gallay Limited installed a salt bath furnace and a vacuum furnace. These have also enabled them to do contract work for various Ministries and other interested parties.

Basic Design Considerations

(a) Materials used must be brazable, only a limited amount of copper (0·05 per cent) should be present and only about 2 per cent of manganese or magnesium.

(b) Any type of joint is brazable even to pure butt, although for reasons of strength a lap joint is preferred. The design must allow for the flux to circulate and drain away as flux residues have corrosive properties. Because of this, on no account must flux be trapped so that the joint cannot be cleaned afterwards. Fig. 1 shows details of joint design.

(c) Gap size on components is important; if it is too large it will not fill, if too small the molten brazing alloy cannot flow across it. The ideal size is between 0·003 and 0·005 in.

Joints can be brazed with the minimum of distortion and with extremely thin sheet down to 0·006 in thick. Joining of such sheet could not be contemplated by torch brazing. Flux bath brazing also provides heating of such uniformity that the degree of distortion experienced is very small indeed and extremely close tolerances are regularly specified. Oxygen is completely excluded in the salt bath and the temperature is uniform. The flux is particularly fluid so that it will flow through any joint.

Since the filler alloys used for flux bath brazing are principally aluminium with small percentages of silicon and sometimes copper, it will be appreciated that the temperatures involved in the process reduce the mechanical properties of the materials being brazed to those given by manufacturers for the alloy in the annealed condition. As brazable alloys must necessarily have higher melting points than filler alloys, it is suggested by Delaney Gallay that they are consulted on this point.

In this country, aluminium brazing has mainly been used for heat exchangers and wave guide work, but there are many applications for small intricate components made up of many parts. The process allows for completely inaccessible joints to be brazed and joints which cannot be seen. Small components are fairly expensive to do, but larger ones like the heat exchanger in Fig. 2 work out economically.

The secondary surface heat exchanger matrix (Fig. 2) contains hundreds of feet of brazing. The material used is aluminium clad with brazing alloy. The cladding is aluminium with 5 to 10 per cent silicon to give variation in the melt point; the joint only taking up as much of the cladding as it needs. Fig. 3 shows where the joints are made in a heat exchanger matrix.

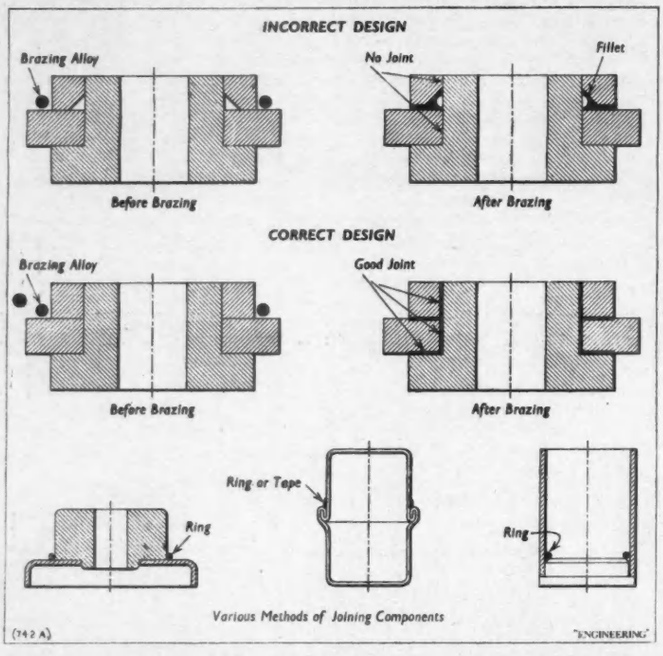


Fig. 1 (left) Details of joint design. The design must allow for the flux to circulate and drain away.

Fig. 2 (right) Typical secondary surface heat exchanger matrix in light alloy.

Fig. 3 (centre right) Where the joints are made on a matrix such as that shown in Fig. 2.

Fig. 4 (lower right) Complex components such as this wave guide assembly for Decca Radar are an ideal case for using flux bath brazing.

The wave guide assembly for Decca Radar in Fig. 4 is a very complicated component. They were previously made in brass which trebled the present weight. When aluminium was first tried, aluminium solder was used, but joints could not be guaranteed. Because of vibration, when the wave guide was in use, the physical strength was not good enough. Epoxy resins were tried for a bond but electrical leakage paths were too great. Silver plate on aluminium was tried, so was copper on silver, then soft soldering encasing the whole thing in epoxy resins to give it physical strength, because solder on aluminium comes adrift near to the soft soldering temperature! The use of the aluminium flux bath brazing has proved to be the ultimate answer.

Components are jigged or self-jigged, the jigs themselves being made of 18/8 stainless steel, the only material to stand up to the salt bath.

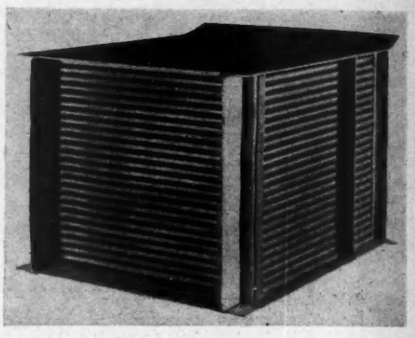
Vacuum Furnace Brazing

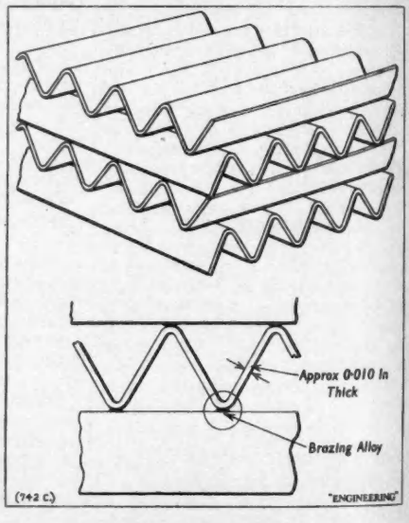
Delaney Gallay have one of the largest vacuum brazing plants in Europe. This process is suitable for joining such metals as corrosion and heat resistant alloys, refractory metals, magnetic alloys low-expansion alloys and cermets and ceramics. The vacuum method has big advantages over the use of controlled atmospheres. There is no risk of contamination of the parts being joined, and the possibility of porosity in the joint is reduced as out-gassing of the molten filler occurs before it solidifies to make the braze, produces a sounder joint and, as no flux is required, there are no cleaning problems.

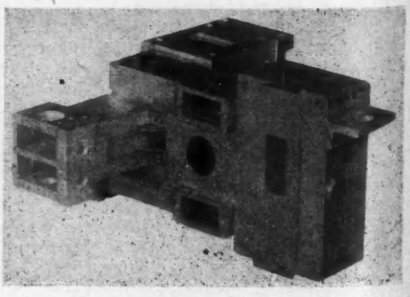
The upper temperature normally used in the furnace is 1,250° C but this can be increased to 1,600° C. Because temperature control of the furnace is very close, it is possible to achieve good joints in metal foils such as those used in the production of honey-comb and other heat exchanger structures; the degree of distortion being far less than that obtained in plants where such close temperature control is not possible.

Both the aluminium flux bath brazing and the vacuum furnace brazing processes mentioned above are being carried out by Delaney Gallay whose metallurgical laboratories are available to carry out any further research required.

Delaney Gallay Limited, Metallurgical Laboratories, Brazing and Special Welding Section, Vulcan Works, Edgware Road, London NW2.







Tankers for Liquid Methane Create Design Problems

Following the announcement that the Gas Council is to import liquid methane gas from the Sahara into this country, some details have been released by Vickers-Armstrongs (Shipbuilders) Limited, about the tanker they are to build at Barrow, for the carriage of the liquid. Another will be built by Harland and Wolff Limited of Belfast.

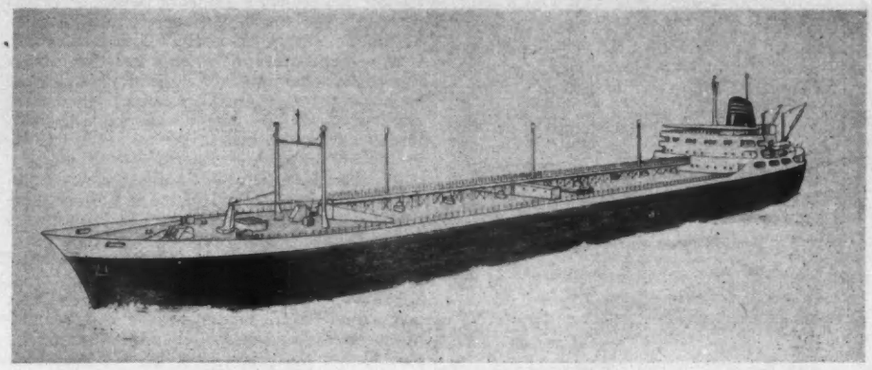
The two tankers will each have a capacity of about 12,000 tons of liquid methane and their dimensions will be 610 ft long overall by 80 ft beam. This is about the same size as a 28,000 ton tanker and is due to the low specific gravity of the cargo (0·45). The tankers, which will have a service speed of 17¼ knots, will each cost about £3,500,000.

It is hoped that the two tankers will begin to operate in about 2½ years time when they will convey up to 354 million therms per annum to the Canvey Island terminal. The specifications to which they will be built are to those laid down by Conch International Methane Limited, who jointly with the Gas Council operated the "Methane Pioneer".

Vickers say the tanker they are to build will, of necessity, be a novel vessel specially designed to carry the exceptionally low temperature methane (— 258° F) and it will call for the fullest use of the Barrow shipyard's facilities, including those of specialized welding.

It is interesting to recall the existing liquid methane carrier, the Methane Pioneer, which brought her first cargo from the Gulf of Mexico to the storage tanks on Canvey Island in January, 1959. She made a series of seven trial voyages and carried about 2,000 tons of liquid methane each time; the experiment was said to be completely successful. A converted vessel of some 4,000 tons, she has five rectangular aluminium tanks each of which has a capacity of 400 tons of liquefied gas. Insulation is effected by 12 in thick laminated balsa wood, sandwiched between the inner aluminium and the outer steel jacket.

Safety measures with the Methane Pioneer were strictly enforced, but basically the handling of liquid methane at atmospheric pressure is said to be safer than oil. Nevertheless there was a system for detecting and counteracting any leaks in the tanks, piping and fixtures in addition to strict ventilation of surrounding hold space and regular inspection of the insulation.



Artist's impression of the tankers to be built in British shipyards for transporting liquid methane.

The Methane Pioneer had a double bottom and wing tanks to allow special ballasting. This was to ensure that the inner steel plating of the ship's hull which encloses the cold tanks is maintained at the ambient temperature. The design had to allow for the expansion of the tanks if and when they were not holding the liquid gas. In addition they had to be situated for maximum stability which is a problem with a vessel carrying a load with such a low specific gravity. The machinery was aft which avoided the complications of the propeller tunnel passing through the aft holds.

Vickers say that not only will the tanker they are to build be of unusual form structurally, but the main machinery and auxiliaries will differ from normal practice. What this means exactly is at this stage a matter of conjecture but it is possible that the new vessel could be powered by methane. It was said at the time the Methane Pioneer was converted that the continuous "boiling off" from the cargo tanks—about half of 1 per cent per day—could be used as the source of motive power.

Vickers contract includes the fabrication of the large special-quality aluminium tanks for the cargo and because of the very low operating temperatures involved special welding techniques will be required. Following the early stages of discussion about the project, the company has carried out certain basic investigations with regard to methods of welding and insulation procedures for the aluminium alloy as a background to the work about to be undertaken. The company's experience with welding the aluminium superstructure of the liner Oriana and current submarine programmes will be of value in this connection.

At the Barrow shipyard a new welding centre was recently opened. Here five skilled instructors can give the advanced training necessary for this specialized welding to fifty welders at any one time.

The insulation of the cargo tanks represents a very special feature and Vickers say that the work involved will occupy a labour force many times that normally associated with a tanker of equivalent size.

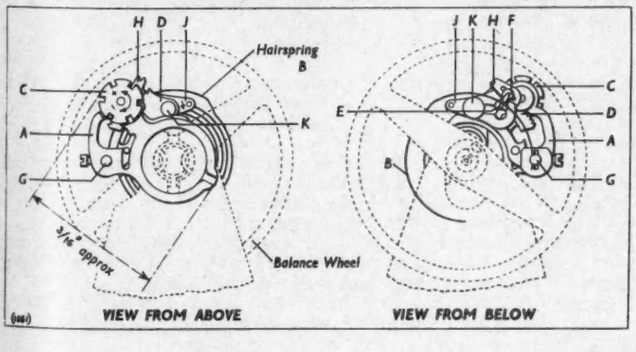
In next week's issue we hope to give more technical details of the design and construction of such tankers.

The Triostat: A Precision Regulator for Watches

A watch regulating device which allows the watchmaker to obtain easy regulation with a high degree of accuracy has been developed in Switzerland by the Universal Escapement Limited, famous for the Incabloc mountings.

The regulator, known as the Triostat, has many advangates over the classical type of regulator and permits full use of the potential precision of the modern watch. The work of manufacturers and repairers is said to be easier, quicker and more precise as all problems of beat setting and regulation are solved by the moving stud device and the regulating star. The adjustment lever for hairspring shake—the motion of the hairspring—minimizes the retouching of position regulation. In addition, cleaning and maintenance are simplified.

Although appearing as a complicated assembly, the Triostat is relatively simple as examination of its parts, their functions and inter-relation will show. The principal part consists of the main body, which has a split ring without a tail—usual in a normal regulator. This component also has an arm A. In the normal regulator, this arm carries the curb pins, or curb pin and boot but with the Triostat the arm serves to carry the stud G, which is held by a screw in such a way that its height is easily adjustable.



The Triostat regulator adds precision to a watch. The work of manufacturers and repairers is said to be easier, quicker and more precise, as all problems of beat setting and regulation are solved by the moving stud device and the regulating star.

The arm A also carries the regulator star-wheel C, rotation of which allows adjustment to be made to the daily rate of the watch. A pinion which engages with the toothed sector D is also mounted on the star-wheel, C, being concentric with the balance pivot. A round pin E is also carried on sector D, as is piece F (riveted to lever J) which terminates in an elliptical stud. This stud can be moved towards or away from the pin E by the lever H, so that the clearance of the spring B between the pin E and stud F can be adjusted.

A fly-back lever J allows the curbs E and F to be opened widely, thus freeing the spring completely without risk of modifying the clearance between it and the curbs when they are closed again.

The Triostat simplifies to advantage the following operations: (1) setting of the beat, (2) adjustment of the clearance between the curbs, (3) adjustment of the rate of the watch and (4) releasing the spring. All these operations are said to be easily carried out.

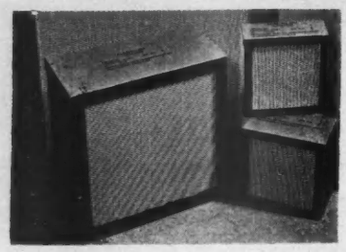
Some degree of the precision miniaturization of the Triostat can be obtained when it is remembered that the overall length of the device for a man's watch is about $\frac{3}{10}$ in.

The Universal Escapement Limited, 165 rue Nurma-Droz, La Chaux-de-Fonds, Switzerland.

High Efficiency Air Filters

Biological tests using bacteria and virus size particles are said to have shown that a filter with a sodium chloride penetration of less than 0·003 per cent can be regarded as 100 per cent efficient for the removal of all biological particles down to the smallest known virus and is therefore capable of producing sterile air.

Following a study on the removal of submicron particles from an air stream by mechanical filtration, a new range of filters for air conditioning and ventilation schemes has been developed and is being produced by E. N. Mackley and Company. The company say that the sodium flame test, said to be the most stringent and flexible method, is used for testing the filters and has considerably aided their development.



Filters capable of producing sterile air.

Three grades of filter are being made. The most efficient has a penetration of less than 0·001 per cent with a pressure drop of less than 0·5 in wg. It is said to be capable of removing all radio-active particles of virus and bacteria down to the smallest known virus to give sterile air conditions. The other two grades give 0·01 and 5 per cent penetration.

The filter elements are protected by expanded aluminium on the inlet and outlet facings.

E. N. Mackley and Company, Hawks Road, Gateshead 8, Co Durham.

Single Tank 132 kV Oil Circuit-Breaker

AEI have recently carried out successful proving tests, at the Switchgear Testing Company Limited, Manchester of their latest addition to the type JB single tank, bulk oil circuit-breakers. The rating was 2,500 MVA at 132 kV.

Experience gained with the first 132 kV unit which was made by the then BTH Company, coupled with the application of improved interrupters, has led to the new breaker, designated type JB 431. It has an impulse withstand level of 650 kV. Each interrupter is shunted by a linear wire wound resistor and the full current of 10·9 kA is interrupted in less than three cycles.

The JB 431 requires only about 1,000 gal of oil and is said to be a most economic and compact design. In spite of all three phases being in the one tank and no interphase barriers, the space for maintenance within the tank is claimed to be greater than in a conventional three tank breaker, and maintenance can be carried out on all three phases at one time with complete disregard for the weather.

Associated Electrical Industries Limited, Crown House, Aldwych, London WC2.

Inter-Service Unit for Hovercraft Trials

The Admiralty have given approval for an inter-Service hovercraft trials unit to be set up in HMS Ariel at Lee-on-Solent. The aim of the trials to be carried out there will be to provide information to assist in determining the possibility of using hovercraft for military purposes and in addition for the formulation of staff requirements.

Before the SRN1 hovercraft demonstrated its ability to run at high speed over land and water, the Services and the Ministry of Aviation had been in close touch with developments. The hovercraft's future in many military roles will largely depend on the sea keeping ability ultimately achieved. The indications are, however, that there are good prospects of the hovercraft's seaworthiness being developed to such an extent as to enable them to be used satisfactorily in operational conditions.

In the execution of anti-submarine and amphibious warfare and in the logistic support of Army units the hovercraft may be able to make a significant contribution. Other roles could include air-sea rescue, mine hunting and coastal forces duties.

The slipway and airfield at HMS Ariel are being made available for use by experimental hovercraft constructed by industry and the nucleus of the trials unit has already been formed.

Single Line Tracklayer

A prototype single line tracklayer is in use on the Eastern Region of British Railways. Known as the "Arki-Endon" and adapted from a Continental design it has the advantage of being able to operate without having possession of the adjacent track.

Thus not only does the Arki-Endon leave one line free on double track routes but it means that single track routes can be laid mechanically whereas previously they had to be done by hand.

This tracklayer does not possess the adjacent track and gives adequate clearance to overhead electric power lines.

In addition, the tracklayer is particularly suitable for use on the Eastern Region electrified lines as it can be used under the overhead wires with adequate clearance.

The machine consists of five portal cranes, power driven and self-propelled dispensing with the need for a prime mover as is required with a conventional tracklayer. Each portal is fitted with a lifting bale of three tons capacity. The unit travels to and from the relaying site on two "Sturgeon" wagons modified for the purpose, the whole being within the gauge.

The guide or service rails are formed from long welded rails previously brought to the site and with which the track will be re-railed after the initial laying in of 60 ft lengths of prefabricated track. The 300 ft long welded rails are lifted by small portals, to sit at about 15 ft centres on specially made lifting and traversing jacks supplied with the equipment.

The appliance safely lifts a 15 ton load and will deal with 60 ft lengths of concrete sleepered track having the maximum number of concrete sleepers required. The height of the portals enables the machine to deal with three tiers of concrete sleepered track or four tiers of timber-sleepered track on Sturgeon wagons. Manufacturers of the Arki-Endon tracklayer are *Heinrich Arneke and Company, Seelze, Nr. Hanover, Germany.*

Suction Pyrometer for Accurate Measurement

In the evaluation of the performance of oil-fired appliances, the measurement of flue gas temperature is of great importance. Because of radiation losses and because the gases are not thoroughly mixed before the flue is reached errors of 10 to 20 per cent can be recorded by inserting thermometers or thermocouples in the flue gas.

In order to overcome this problem, engineers at the Central Laboratories of Shell International Petroleum Company have designed a simple suction pyrometer in which the flue gas is pumped at high speed over a thermocouple mounted in a shielding tube. Suction is provided by the Shell Moray Smoke Meter, another device developed in the same laboratory and manufactured by Delta Technical Services Limited. Pyrometer readings are recorded by a small portable indicator made by Evans Electroselenium Limited. Temperatures of up to 1,000° C can, it is claimed, be read with an accuracy of 2 to 3 per cent.

A report giving details of construction and operation of the pyrometer can be obtained free of charge from the *Industrial Fuels Department, Shell-Mex and BP Limited, Shell-Mex House, Strand, London, WC2.*

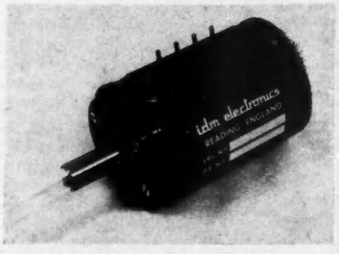
Precision Slip-Ring Assemblies

The introduction of the first of a standard range of precision slip-ring assemblies has been announced by IDM Electronics. They have been specifically designed for strain gauge, thermocouple and other instrument applications needing a small power unit giving low frictional torque, low electrical noise and long life.

It is claimed that electrical noise levels of less than 3 microvolts/milli-amp peak-to-peak are achieved at speeds up to 3,000 rpm. This is made possible by using small diameter electrodeposited silver rings and silver graphite brushes. The life of the units is said to be in excess of 1,000 hours at 3,000 rpm, after which time they may be returned for servicing. Recommended maximum speed is 10,000 rpm.

Contact resistance is 0·07 ohms per circuit including leads, and insulation resistance between circuits is claimed as better than 200 Megohms at 500 volts dc. The slip ring which has a shaft diameter of 0·3125 in is mounted in a 1·5 in diameter synchro type housing, the overall length being 3¼ in.

Illustrated is an 8-way version, but a 12-way unit is also made. Assemblies with a marker ring for counting purposes, or with special leadwires



Slip ring assembly for obtaining strain gauge or thermocouple readings from rotating parts.

for critical thermocouple applications are available. The assemblies may be cantilever mounted from the end of a shaft with a simple torque arm preventing rotation of the housing or for high speed applications they can be rigidly clamped to a base plate and the shaft driven through a flexible coupling.

IDM Electronics Limited, Whitley Kiln, Basingstoke Road, Reading, Berks.

Avoiding Fatigue Failure in Big-Ends

Future high combustion pressures will focus attention on the design of big-ends. Diesel experience shows the need for obtaining high rigidity and correct location of oil feed points.

THE line of development for engines can be seen as the achievement of higher power outputs per cu. cm. While this development will depend on the use of higher compression ratios, better combustion chamber design, more efficient cooling, higher grade fuels, etc., it will also call for improved mechanical design of parts of the engine outside the cylinders. The big-end bearings, for example, are directly affected by the trend towards increased combustion pressures.

At present the design of such bearings is quite adequate. But it is possible that under more arduous conditions, weaknesses could appear in bearing assemblies that have hitherto given satisfactory performance. This has already happened in large diesel engines, with the introduction of turbochargers, and the experience gained in this field provides useful pointers to solutions for future problems in petrol engines.

Failures of plain bearings in internal combustion engines can usually be attributed to wear of the shaft (due to dirt in the oil), fatigue of the bearing metal, or corrosion. Of these, the designer has most control over fatigue loading. In addition, when designing a connecting-rod big-end bearing for dynamic loading, more reliance can usually be placed on the criterion for fatigue than on that for oil film thickness, as the latter is not known accurately in the dynamically-loaded case.

However, published data on bearings with similar material specifications show variations in opinion as to the loads that can be carried. This can be due to the variations in methods of measurement. Also there are a number of design aspects that are not fully understood, notably, grooving design, housing rigidity, bearing clearance, shell thickness, casing distortions and crankshaft deflections.

In a paper "Design Factors Influencing the Fatigue Resistance of Connecting-Rod Big-End Bearings," presented to the Institution of Mechanical Engineers by E. A. Blount, experiments are described in which attempts were made to evaluate the effects of these variables.

LOADING TESTS

The author, Section Leader in the research laboratories of D. Napier and Son Limited, Acton, points out that a test machine capable of representing all the characteristics of the loads on an engine bearing would be much too complex. A machine was therefore designed to apply cyclic loading that reproduced only the main characteristics. The loading cycle was repeated once every revolution, in the form of reasonably sharp load peaks of adjustable amplitude and narrowness, which could be applied to either or both sides of the bearing. Cyclic loads were developed by making the journal eccentric and resisting the resultant motion of the bearing housing by hydraulic means. Journal speeds between 250 and 1,250 rpm could be accommodated. Maximum peak load was ± 10,000 lb.

During the tests to determine the effect of different variables on the fatigue life of bearings, the journal speed was 1,000 rpm and the loading frequency 1,000 cpm; specific loads employed were 2,125; 3,190; 3,720; and 4,520 lb per sq. in.

The influence of housing rigidity was quickly demonstrated. When thick shell copper-lead bearings were housed in an engine connecting rod they failed within 25 hours at a load of 3,190 lb per sq. in; whereas another, housed in a very rigid rig housing, completed 69 hours at 4,250 lb per sq. in without failure. Similar increases were noted with white-metal bearings.

The manner in which a diesel engine big-end with thick-wall bearings was redesigned for thin-wall bearings and high rigidity is shown in the drawing. By careful attention to design details to reduce the distortions of the rod eye during assembly and flexing under load, an increase in load carrying capacity of about 1,000 lb per sq. in has been obtained.

Grooved thin-shell bearings were found to be able to carry an increase in fatigue load of about 1,000 lb per sq. in compared with grooved thick-shell bearings. Less increase was noted in ungrooved types.

A circumferential oil groove was found to reduce the fatigue load that could be carried by the bearing. It was noticeable in the tests that the grooved bearings tended to run hotter than the ungrooved ones. From other investigations on this same type of bearing it has been found that if the temperatures are compared on a basis of constant oil flow, the grooved bearing runs between 6 and 8° C hotter than the ungrooved bearing over a wide range of oil flows. This implies that although an increase in oil flow from the grooved bearing may tend to reduce the bearing temperature, the accompanying reduction in oil film thickness and increase in the heat generation more than cancelled the benefit from the increased oil flow.

The test rig gave a reasonable approximation to an engine during the firing load, in as much as oil was supplied to the loaded area of the bearing just prior to the application of the firing load. The hydrodynamic lubrication condition would, however, be better in an engine because of the reverse rotation of the load vector.

This was not necessariy true during inertia loading, particularly in the period immediately following the firing load. Although the loading might be less than the firing load, the hydrodynamic lubrication conditions were adverse because the speed of rotation of the load vector approached half that of the journal. The oil supply to the loaded area of the ungrooved bearing during this period was also poor because the oil hole in the crankpin was positioned to give a change of oil before the firing load. The oil was then displaced by this load and not replenished before the inertia load. This could have been affected by including a circumferential groove.

On the one hand the inclusion of an oil groove will increase the maximum oil film pressures but will have little effect on the bearing temperature during the firing load. On the other hand it may reduce the bearing temperature during the inertia load. The inclusion of a single oil hole at the crown of the rod shell for oil transfer to the small-end has the same effect on fatigue strength as an oil groove. To ensure the maximum fatigue strength in the position of the highest load at the crown of the rod shell an arc of 90° was left free from grooves or oil holes.

SHELL CONSTRUCTION

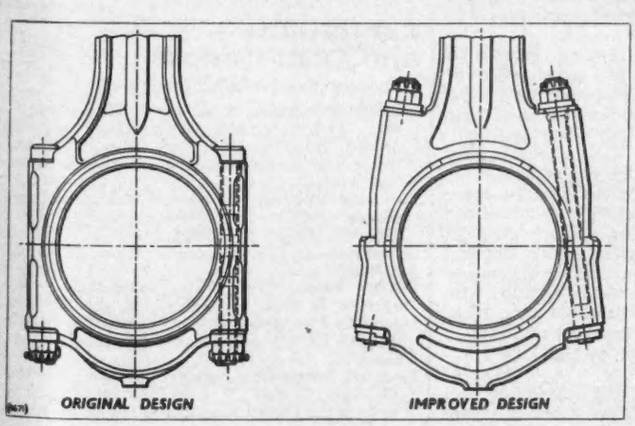
The effect of different methods of manufacture and composition of the bearing was also investigated. The fatigue ratings for the statically cast thin-shell white-metal bearings were slightly less than those of similar white-metal bearings which were strip-line cast. The cause of the shorter fatigue life was considered to be the coarser structure of the statically cast bearings.

An aluminium-tin thin-shell bearing gave a fatigue performance rating of at least that of the thin-shell white-metal bearings, but severe scoring of the bearing prevented the test from continuing to higher loads. In these and in other tests conducted at the laboratory, there was a tendency for aluminium-tin bearings to score more readily than white metal when operating under conditions of severe loading. However, it is not suggested that this is necessarily a limitation in practice, since the rig loads were considerably in excess of engine loads, and the particular aluminium-tin bearings used were of an early experimental batch.

Trimetal bearings consisting of a thick steel shell, lead-bronze intermediate layer and a white metal surface were also tested. On the first, no visible cracks were produced by running up to the full rig load of 4,250 lb per sq. in. However, examination by a fluorescent crack detection process revealed a network of very fine cracks in the loaded area of the rod shell. There was a complete absence of cracks in the centre, owing to lack of support for the shell in the region of the oil hole in the housing. The effect of a 0·140 in diameter thermocouple hole below was also apparent. This type of failure was similar to to those obtained in engines after about 10,000 hours of service, and it is surprising to find that the lack of shell support should have such an effect on bearing shells of comparatively large thickness. The direction of these cracks was axially across the bearing, which is again indicative of shell flexing in this type of assembly.

On the second and third trimetal bearings examined, the crack detection process was used for each intermediate-load inspection and it was then found that the fine cracks first appeared at about the same test condition that produced fatigue failures on the white-metal bearings.

It was therefore concluded that the trimetal bearing is no more resistant to fatigue cracks than plain white-metal bearings, but that it was superior in that the excellent bond between the white metal and the lead-bronze prevents the wholesale break-up of the surface. Considering the severity of the test condition and the amount of running necessary to produce a break-up of the white metal there seemed little justification for regarding fine cracks as a failure condition. So the trimetal bearing was given a higher fatigue rating than the plain white-metal bearing.



Engine requirements limit the extent that big-ends can be redesigned to produce high rigidity. Here, the use of thin wall bearings helped considerably.

Plain Words

By Capricorn

BURIED treasure has an irresistible appeal. During the course of years, many extremely expensive expeditions have been sent out to find the lost hoards. The hope of discovery has led others to work on research projects and experimental designs, leading to something wholly new. There is a source of buried treasure for them too: it lies in an office in London—in the part of London where the streets are paved with gold.

An immense number of scientific and engineering ideas have found their way on to paper and have been deposited in the archives of the Patent Office. On those thousands of feet of bookshelves there are ideas galore, many of them useless, some completely fantastic, but a few of real value. Here may lie a rich treasure for the investigator, because ideas that in the past have seemed fantastic when put on paper are now commonplace things of life. When the Patent Office files were started, aeroplanes were a dream, motor-cars were unheard of, and electric trains and dictating machines were equally fancies of a disordered imagination.

Yet there were some forward-looking people who in their ideas had a germ of truth, who could dream better than they could build. They registered their ideas in patents, but could go no further, perhaps for lack of suitable materials or techniques which have since become available. Imaginative and original thinkers are more often than not in advance of their contemporaries, and are inclined to lose heart when they fail to excite the response to which they think they are entitled.

I am sure a carefully planned search among the old patents would yield a pearl or two of very great price. We could make good use of some new ideas, even if they are old new ideas. These pearls are available for the searching, though a search would take time and labour, and a highly developed sense of discrimination. Much useless material would have to be turned over and scanned, but it could be a worthwhile undertaking for someone who is prepared to put drive and energy into a new scheme. The idea cannot be called fantastic because there are many, many examples of pearls that have been lost, published in unusual places and not found until many years afterwards.

It is a source of buried treasure that is open to anyone with the ability, and one that has been greatly neglected. Think of the stories that would come to light: of the ideas that have been put forward, that have been bought up and neglected, or have failed for lack of faith. Many of them might well be revived again and perhaps a great development would follow. There is no Long John Silver in the Patent Office Library, so you've no need to take pistol or cutlass, but remember to take a tame librarian or information officer with you. If you're a really bright boy, you'll patent a machine to do the reading for you.

Letters to the Editor

Completion of the Tamar Bridge

SIR, I read with interest your article on the completion of the Tamar Bridge (ENGNG., 3 Nov. '61, p. 573).

One statement, however, appears to be in error; where it is claimed that no suspension bridge has been erected in this country for 66 years. May I draw your attention to the erection of the Chelsea Bridge over the River Thames?

This is a suspension bridge built in the period just before the Second World War and opened by the chairman of the London County Council, then Mr. Herbert Morrison, M.P.

Yours faithfully,
J. FARRELL.

Leeds 6.
7 November, 1961.

The Teaching of Structures

SIR, I have for many years taught beam deflections by both the methods referred to by Mr. A. Goldstein in his book review (ENGNG., 27 Oct. '61, p. 554), and consider that his approach is, to say the least, arguable.

The place of mathematics in engineering is that of a tool, and an understanding of the logical discipline of "proper" mathematics, while most valuable from a cultural standpoint, has very little to do with the practical profession of engineering.

I consider the opposite approach to that of Mr. Goldstein the most valuable, that is, to start with visualization of the problem and fit in the mathematics to suit. This applies particularly to the case referred to, in which a simple sketch enables Mohr's theorems to be written down immediately.

The derivation of Mohr's second theorem given by Mr. Goldstein was referred to as "simple and elegant." As an engineer, I was unable to follow it and would much appreciate a sketch to clarify the statement that:

$$\int_0^{x_1}\int_0^{x}\frac{M}{EI}\,dx\,dx=\int_0^{x_1}(x_1-x)\,\frac{M}{EI}\,dx$$

Yours faithfully,
J. H. SWANNELL.

Department of Mechanical Engineering,
Nottingham and District Technical College,
Nottingham.
9 November, 1961.

Events in Advance

Mechanical Equipment for Sewage Purification

THROUGHOUT the past century, substantial advances have been made in the treatment and disposal of municipal sewage, and these achievements have helped to bring about notable improvements in the health of urban communities.

While, in Great Britain, there is no slackening of these endeavours, a new stimulus has come from overseas, where developing countries are trying more and more to bring their own practices into line with the attainments of this country. In these continuing efforts, civil engineers and public health engineers have cooperated with chemists, biologists and bacteriologists. But, at the same time, much of the plant embodied in sewage works has been designed and constructed by mechanical engineers.

Again, aspirations for the future do not depend solely upon traditional types of equipment. Indeed, the onerous and unpredictable duties demanded of such equipment have themselves stimulated the production of new designs, which are quickly brought into service.

For such reasons as these, the Institution of Mechanical Engineers believe that the time is now opportune for encouraging discussions upon the comparative merits of the different methods and equipment, in use or contemplated. Accordingly, the Hydraulic Plant and Machinery Group of the Institution is making arrangements for the holding of a whole-day symposium on "Mechanical Equipment for Sewage Purification Works."

Non-members, as well as members of the Institution are invited to participate. Although initiated by the Institution's Hydraulic Plant and Machinery Group, the range of the symposium will be such as to interest other Groups of the Institution.

Two groups of papers will be presented. The first will survey the field of sewage purification in general.

Papers in the other section will describe the varied types of mechanical engineering equipment that have been produced to meet existing conditions.

The symposium will take place on 1 February, 1962, at the Institution's headquarters. Registration forms and further details may be obtained from the secretary, the Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London SW1, or by telephoning WHItehall 7476.

Selling to Europe

ARRANGEMENTS are well under way by the Export Council for Europe for holding a national convention at the Winter Garden, Eastbourne, from 29 November to 2 December next on the general theme "Selling to Europe."

The purpose of the meeting is to explore fully and frankly all practical means for further expanding British exports to the Continent. Special emphasis will be laid upon the opportunities, methods and action which must be taken in order to secure maximum results.

The Export Council for Europe was formed as recently as November, 1960, at the instigation of the President of the Board of Trade in order to expand exports of British goods and services to the other 19 countries that are members of the Organization for European Economic Cooperation. The coming convention, therefore, forms a fitting climax to the Council's first year's activities and will provide an opportunity to review the results of their endeavours and, in the light of discussion, to determine what shall constitute their most effective future action.

There will be three plenary sessions and two main working sessions. In these, delegates from all sections of British industry will be able to exchange ideas and information quite freely, in order that individual knowledge and experience may be shared generally.

Further information may be obtained from the conference secretary, Export Council for Europe, 21 Tothill Street, London SW1, or by telephoning WHItehall 2256.

Exhibitions and Conferences

Arranged in chronological order

Solids-State Circuits Conference, International.—Wed., 14 Feb., to Fri., 16 Feb., 1962, in Philadelphia, Pennsylvania, USA. Organized by the Institute of Radio Engineers, 1 East 79th Street, New York 21.

Radio and Electronic Components Exhibition, International (FNIE).—Fri., 16 Feb., to Tues., 20 Feb., 1962, in Paris. Organized by the Federation Nationale des Industries Electroniques, 23 Rue de Lübeck, Paris 16.

Leather Goods Trade Fair, International.—Sat., 17 Feb., to Thurs., 22 Feb., 1962, at Offenbach. Organized by Offenbacher Messe-Gesellschaft m.b.H., 110 Kaiserstrasse, Offenbacher-on-Maine, Germany.

Frankfurt International Spring Fair.—Sun., 18 Feb., to Thurs., 22 Feb., 1962, in Frankfurt. Applications in the United Kingdom should be addressed

to Lep Transport Ltd., Sunlight Wharf, Upper Thames Street, London EC4. Tel. CENtral 5050.

Display Market Week.—Mon., 19 Feb., to Thurs., 22 Feb., 1962, at the Hotel Russell, Russell Square, London WC1. Organized by the National Display Equipment Association, 2 Caxton Street, London SW1. Tel. ABBey 4813.

Human Implications of Plans to Increase Productivity One-Day Meeting.—Thurs., 22 Feb., 1962, at the Federation of British Industries, 21 Tothill Street, London SW1. Organized jointly by the Central London Productivity Association and the British Productivity Council. Apply to Mr. R. G. Cattell, hon. treasurer, Central London Productivity Association, 54 Alderney Street, London SW1.

Household Goods and Hardware Fair.—Fri., 23 Feb., to Mon., 26 Feb., 1962, in Cologne. In the United Kingdom, apply to the Du Mont Publicity Co., Ltd., 18 Queensberry Place, London SW7. Tel. KENsington 1700.

Meetings and Papers

The address and telephone number of the headquarters of each institution are given at the end of this list. Meetings in the headquarters town are held there unless otherwise stated.

Association of Supervising and Electrical Engineers

CROYDON
"National Inspection Council for Electrical Installation Contracting," by E. J. Sutton. South London Branch. Greyhound Hotel, Croydon. Thurs., 23 Nov., 8 p.m.

British Institution of Radio Engineers

LONDON
"An Experimental Assessment of Loudspeaker Performance," by R. Yorke. Electro-Acoustics Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 29 Nov., 6 p.m.

CHELTENHAM
"Electronic Telephone Exchanges," by J. F. Hesketh. South Midlands Section. North Gloucestershire Technical College, Cheltenham. Fri., 1 Dec., 7 p.m.

FARNBOROUGH
"Data Acquisition Systems," by K. L. Smith. Southern Section. Technical College, Faraborough. Tues., 28 Nov., 7 p.m.

British Interplanetary Society

LONDON
"Materials in Space Technology": Whole-Day Symposium. Royal Aeronautical Society, 4 Hamilton Place, W1. Wed., 22 Nov., 9.30 a.m.

Engineers' Guild

BRISTOL
Address by S. F. C. Whitmore, deputy chairman of the South Western Electricity Board. Luncheon Meeting. Berkeley Restaurant, Bristol. Thurs., 23 Nov., 12.30 for 1 p.m.

Illuminating Engineering Society

BIRMINGHAM
"Lighting of Large Office Buildings," by J. H. D. Madin. Birmingham Centre. Chamber of Commerce, 75 Harborne Road, Edgbaston, Birmingham 15. Mon., 27 Nov., 6.30 p.m.

Institute of Information Scientists

LONDON
"Films for the Communication of Science," by Dr. A. R. Michaelis. AEI House, 33 Grosvenor Place, SW1. Wed., 29 Nov., 6.30 p.m.

Institute of Marine Engineers

LONDON
"High-Temperature Reactors for Marine Propulsion," by Dr. J. E. Richards. Joint Panel on Nuclear Marine Propulsion. Tues., 28 Nov., 5.30 p.m.

PLYMOUTH
"Automatic Control of Naval Boilers," by Commander J. P. H. Brown and Lieut.-Commander W. J. R. Thomas. Devon and Cornwall Section. Royal Naval Engineering College, Manadon, Plymouth. Tues., 28 Nov., 7.15 p.m.

Institute of Metals

SHEFFIELD
"Inclusions in Metals": Symposium. Papers by B. P. Barnsley, T. R. Allmand and Dr. D. A. Melford. Sheffield Local Section. Applied Science Building, The University, St. George's Square, Sheffield. Thurs., 23 Nov., 2 p.m.

Institution of Agricultural Engineers

BIRMINGHAM
"Equipping the Newly Developing Countries with Agricultural Machinery," by N. M. Garrard. West Midlands Branch. Gosta Green Technical College, Birmingham. Mon., 27 Nov., 7.30 p.m.

Institution of Civil Engineers

LONDON
"Development of Modern Dry Dock Equipment," by John Read. Tues., 28 Nov., 5.30 p.m.
"The Relative Merits of Rigid and Flexible Construction for Quays and Jetties": Informal Discussion, to be introduced by D. H. Little. Thurs., 30 Nov., 5.30 p.m.

Institution of Electrical Engineers

LONDON
"Recent Developments in Semi-conductor Devices and Their Applications," by E. Wolfendale. Electronics and Communications Section. Wed., 29 Nov., 5.30 p.m.
"Backward Waves in Waveguides": Discussion, to be introduced by Dr. P. J. B. Clarricoats, R. A. Waldron and G. H. B. Thompson. Electronics and Communications Section. Mon., 4 Dec., 5.30 p.m.

BIRMINGHAM
"A Materials Course for Electrical Engineers"; Discussion to be introduced by Dr. G. T. Wright. South Midland Centre Education Discussion Circle. College of Technology, Gosta Green, Birmingham. Fri., 24 Nov., 6.15 p.m.

EDINBURGH
"An Impression of Moscow," by Professor M. G. Say. South East Scotland Subcentre. Carlton Hotel, North Bridge, Edinburgh. Tues., 28 Nov., 7 p.m.

FARNBOROUGH
"Brushless Variable-Speed Induction Motors Using Phase-Shift Control," by Professor F. C. Williams, Dr. E. R. Laithwaite, K. F. Eastham and W. Farrer. Southern Centre. Farnborough Technical College, Farnborough. Tues., 28 Nov., 6.15 p.m.

GLASGOW
"The Banana-Tube Display System: A New Approach to the Display of Colour Television Pictures," by Dr. P. Schagen. South West Scotland Subcentre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. Wed., 29 Nov., 6 p.m.

KETTERING
"The Kariba Dam Project: Electrical Installations," by C. J. Dickinson. East Midland Centre. George Hotel, Kettering. Wed., 29 Nov., 7.30 p.m.

NEWCASTLE UPON TYNE
"The Place of Formal Study in the Post-Graduate Training of an Electrical Engineer," by N. N. Hancock and P. L. Taylor. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 27 Nov., 6.15 p.m.

NOTTINGHAM
"The Application of Electronics to the Electricity Supply Industry," by Dr. J. S. Forrest. Third Hunter Memorial Lecture. East Midland Centre. The University, Nottingham. Tues., 29 Nov., 6.30 p.m.

PORTSMOUTH
"Technical and Economic Aspects of the Supply of Reactive Power in England and Wales," by W. Casson and H. J. Sheppard. Southern Centre. Offices of the Central Electricity Generating Board, High Street, Portsmouth. Wed., 29 Nov., 6.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

DUNDEE
"The Atom in the Future," by W. R. Wootton. Joint Meeting with the Dundee Institute of Engineers. Dundee Technical College, Dundee. Fri., 24 Nov., 7.30 p.m.

Institution of Heating and Ventilating Engineers

EDINBURGH
"The Heating and Ventilating of Coventry Cathedral," by A. F. Myers. Scottish Branch. 25 Charlotte Square, Edinburgh. Tues., 21 Nov., 7 p.m.

Institution of Highway Engineers

DURHAM
"Surface Dressing": Discussion. Science Laboratories, University of Durham, Durham City. Fri., 24 Nov., 6.30 p.m.

Institution of Locomotive Engineers

LONDON
"Some Problems in Vehicle Riding," by E. S. Cox. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Thurs., 23 Nov., 5.30 p.m.

Institution of Mechanical Engineers

LONDON
Education and Training Group Discussion. Mon., 27 Nov., 6 p.m.
"Agricultural Tractors": Symposium. Tues., 28 Nov., 2.30 p.m. (Admission by ticket only, which is obtainable without charge).
"Can Plastic Components be Designed Rationally?" Discussion. Applied Mechanics and Theory of Materials of Construction Group. Mon., 4 Dec., 6 p.m.

BEDFORD
"The Field of Work Study," by C. Dudley. Eastern Graduate Section. Queen's Engineering Works, Bedford. Tues., 28 Nov., 7.30 p.m.

BRADFORD
"Heat Accumulators in Industry," by W. Goldstern. Yorkshire Branch. Institute of Technology, Bradford. Mon., 20 Nov., 7.15 p.m.

NEWCASTLE UPON TYNE
"The Bearing of Psychology and Medicine on Engineering," by Sir Frederic Bartlett. Repetition of James Clayton Lecture. North Eastern Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 4 Dec., 6 p.m.

READING
"Controlled Fusion Reactions," by Professor P. M. S. Blackett, to be read by Dr. M. G. Haines. Southern Branch. Technical College, Reading. Wed., 29 Nov., 7.30 p.m.

RUGBY
"Cost Reduction in Heavy Engineering," by J. E. Chadbund. Midland Branch. College of Engineering Technology, Rugby. Tues., 28 Nov., 6.30 p.m.

Institution of Production Engineers

DERBY
"Training Foremen," by D. B. Beynon. Derby Section. St. James's Restaurant, St. James's Street, Derby. Fri., 24 Nov., 7 p.m.

LINCOLN
"Numerically-Controlled Machine Tools," by R. C. Brewer. Lincoln Section. Ruston Club, Lincoln. Thurs., 30 Nov., 7.30 p.m.

LUTON
"Static Switching Applied to Machine-Tool Control," by W. G. Turner. Luton Section. Half-Way House, Dunstable Road, Luton. Tues., 21 Nov., 7.30 p.m.

MANCHESTER
"Application of Metal Deposition," by W. E. Ballard. Manchester Section. Manchester College of Science and Technology, Sackville Street, Manchester. Tues., 21 Nov., 7.15 p.m.

Institution of Structural Engineers

EDINBURGH
"Piling," by W. G. N. Geddes. Joint Meeting with the Edinburgh and East of Scotland Association of the Institution of Civil Engineers. Heriot-Watt College, Edinburgh. Tues., 28 Nov., 6 p.m.

SHEFFIELD
"Air Conditioning and Services for Tall Buildings," by J. R. Kell. Yorkshire Branch. Royal Victoria Hotel, Sheffield. Wed., 29 Nov., 6.30 p.m.

SUNDERLAND
"Reinforced-Concrete Bridges," by L. Dobson. Northern Counties Branch. Sunderland Technical College, Sunderland. Tues., 28 Nov., 6.30 p.m.

Iron and Steel Institute

LONDON
"The British Steel Industry and the Common Market" two papers, by Dr. E. N. van Kleffens and C. R. Wheeler. Church House, Great Smith Street, SW1. Wed., 29 Nov., 6 p.m.

Junior Institution of Engineers

LONDON
Film Evening. Fri., 1 Dec., 7 p.m.

Reinforced Concrete Association

LONDON
"Watertight Concrete Basements," by L. R. Creasy. Institution of Structural Engineers, 11 Upper Belgrave Street, SW1. Wed., 6 Dec., 6 p.m.

Royal Institution

LONDON
"The Science of Nature Conservation," by Dr. E. B. Worthington. Fri., 1 Dec., 9 p.m.

Royal Institution of Chartered Surveyors

CARDIFF
"Magnetism, Climate and Coal," by D. E. T. Bidgood. College of Advanced Technology, Cardiff. Sat., 2 Dec., 9.45 a.m.

Royal Society

LONDON
Anniversary Meeting. Thurs., 30 Nov., 2.30 p.m.

Royal Society of Arts

LONDON
"Production for Export," by Reay M. Geddes. Mon., 27 Nov., 6 p.m.
"Television in Schools," by Paul Adorian. Wed., 29 Nov., 6 p.m.

Sheffield Metallurgical Society

SHEFFIELD
"Relative Methods of Various Steelmaking Methods," by T. F. Pearson. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 28 Nov., 7 p.m.

Society of Environmental Engineers

LONDON
"The Response of Dynamic Systems to Shock Excitation," by B. H. Venning. Mechanical Engineering Department, Imperial College, Exhibition Road, South Kensington, SW7. Wed., 29 Nov., 6 p.m.

Society of Instrument Technology

LONDON
"Automatic Plant Analysis by Electrochemical Methods," by R. F. Rodger. Manson House, 26 Portland Place, W1. Tues., 28 Nov., 7 p.m.

CARDIFF
"Differential Producers for Flow Measurement," by H. E. Dall. South Wales Section. Welsh College of Advanced Technology. Cathays Park, Cardiff. Wed., 29 Nov., 6.45 p.m.

CHESTER
"Transistors Applied to Modern Instrumentation," by J. E. Fielden. Chester Section. Stanley Palace, Watergate Street, Chester. Thurs., 23 Nov., 7 p.m.

FAWLEY
"Applications of Transistors and Diodes," by D. Osborne. Fawley Section. Administration Building, Esso Petroleum Co., Ltd., Fawley. Fri., 1 Dec., 5.45 p.m.

SHEFFIELD
"Problems of Flow Measurement," by H. E. Farrer. South Yorkshire Section. Department of Fuel Technology, The University, Mappin Street, Sheffield. Mon., 4 Dec., 7 p.m.

South London Productivity Association

LONDON
"Utilization of the Blind in Industry"; Conference. Federation of British Industries, 21 Tothill Street, SW1. Tues., 5 Dec., 2 p.m. (Conference fee 1 guinea.)

Southampton Metallurgical Society

SOUTHAMPTON
"Organic Detecting and Elimination of Gases in Cast Metals," by Dr. D. V. Atterton. Southampton Technical College, Southampton. Wed., 29 Nov., 7.15 p.m.

Women's Engineering Society

LONDON
Open Discussion Meeting. Hope House, Great Peter Street, SW1. Thurs., 7 Dec., 7 p.m.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London WC1. (LANgham 5927)
British Institution of Radio Engineers, 9 Bedford Square, London WC1. (MUSeum 1901)
British Interplanetary Society 12 Bessborough Gardens, London SW1. (TATe Gallery 9371)
Engineers' Guild, 201 High Holborn, London WC1. (HOLborn 1057)
Illuminating Engineering Society, 32 Victoria Street, London SW1. (ABBey 5215)
Institute of Information Scientists. Apply to Mr. J. Farradane, Torran, Crofton Road, Orpington, Kent.
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London SW1. (BELgravia 3291)
Institution of Agricultural Engineers, 6 Queen Square, London WC1. (TERminus 0140)
Institution of Civil Engineers, Great George Street, London SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WC2. (COVent Garden 1871)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street, London SW1. (ABBey 3891)
Institution of Locomotive Engineers, 28 Victoria Street, London SW1. (ABBey 6672)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London SW1. (WHItehall 7476)
Institution of Production Engineers, 10 Chesterfield Street, London W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London SW1. (SLOane 7128)
Iron and Steel Institute, 4 Grosvenor Gardens, London SW1. (SLOane 0061)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London SW1. (VICtoria 0786)
Reinforced Concrete Association, 94-98 Petty France, London SW1. (ABBey 4504)
Royal Institution, 21 Albemarle Street, London W1. (HYDe Park 0669)
Royal Institution of Chartered Surveyors, 12 Great George Street, London SW1. (WHItehall 5322)
Royal Society, Burlington House, Piccadilly, London W1. (REGent 3335)
Royal Society of Arts, John Adam Street, Adelphi, London WC2. (TRAfalgar 2366)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Environmental Engineers, 167 Victoria Street, London SW1.
Society of Instrument Technology, 20 Queen Anne Street, London W1. (LANgham 4251)
South London Productivity Association. Apply to the Secretary, Mr. A. K. Haskins, Borough Polytechnic, London SE1. (WATerloo 7654).
Southampton Metallurgical Society. Apply to Mr. S. W. Hallwood, Folland Aircraft Limited, King's Avenue, Hamble, Hampshire.
Women's Engineering Society, 25 Foubert's Place, London W.1 (GERrard 5212)

Human Element

The First Real Crunch of the Wage Pause

THE first official strike of the era of the wage pause has stranded several thousand prospective BEA passengers at London Airport, and caused as many more to travel light. Whether or not the strike of 1,000 baggage loaders spreads to even bigger things (perhaps through the aircraft fuelling crews), the way in which it began underlined again the arbitrary and anomalous element which the wage pause has introduced to industrial relations.

Because they work for the Ministry of Aviation, the baggage loaders concerned have drawn blank in their demands for an extra 2½d per hour for the senior loaders in crews working without official supervisors. Nearby, on the same airport, however, baggage loaders doing the same job, but for BOAC, have already secured this extra payment through the accident of being employed directly by the airline instead of by the Ministry. With this example on their doorstep, perhaps it is not surprising that the strikers and their union are expressing self-righteous indignation. To make the position seem even more anomalous to them, the striking baggage loaders are to be transferred to airline payrolls, anyway, next year.

The arbitrary and anomalous consequences of the wage pause have already been seen in the different treatments handed out to wages council recommendations (or awards, as they had come to be regarded until the letter of the law was suddenly invoked), but the airport strike is much the most dangerous reaction so far.

Wage negotiations depend greatly for their success on the fact that the two sides of industry know that, in the last resort, they have to achieve a high degree of agreement to achieve any progress at all. Further, it is important that the people represented at these negotiations should place their confidence in the negotiators. Now that a third force is dictating wage levels from outside the established negotiating machinery, there is no longer a basic need for confidence between negotiators and between representatives and represented.

As any personnel manager could advise the Treasury, in this potentially anarchical situation it is more important than ever that justice should not only be done but should be seen to be done.

More of Problems in Progress

Two more booklets have been published by the DSIR in their "Problems of Progress in Industry" series. No. 11 in the series is *Money for Effort* (HMSO, price 1*s* 9*d*) by Dr. Tom Lupton, and No. 12 is *Human Sciences Aid to Industry* (HMSO, 2*s*).

The former discusses how financial incentive schemes are often regarded as effective means of increasing cooperation between management and managed, yet the evidence suggests that their effectiveness is limited and that they are likely to be less widely applied as production techniques improve. Dr. Lupton shows that 33 per cent of British workers are paid according to some kind of financial incentive, an increase of only 4 per cent since 1939. This relatively slow rate of increase may be interpreted as an indication that mechanization is making incentive schemes redundant; or it may be that such schemes have already been applied to meet most of the tasks for which they are appropriate.

Human Sciences Aid to Industry is concerned with the present situation in which machines are becoming more complex and industrial society more highly organized, yet relatively few industrial firms recognize the value of research on human performance under these conditions. The book demonstrates how the human sciences, based on a scientific study of human behaviour, can lead to a better understanding of the individual in industrial society.

Some of the benefits attained by research along these lines have been very practical. For example, a clash of personalities is often blamed for difficulties arising when technical changes or other innovations are introduced into a firm. Studies suggest that these human relations problems are attributable to failure to adapt the organizational structure to meet the new circumstances.

The Human Difficulties in Shipbuilding

When the British Transport Commission suction dredge "Bleasdale" was launched recently on Clydeside, the deputy chairman of the company which made her appealed for "a greater appreciation of our difficulties on the part of the unions." While urging the unions to pull their weight, however, he did not seem to be much concerned about the responsibilities of management for the question of human relations on which the industry, to use one of its own expressions, appears to be foundering.

Fortunately, the Minister of Labour takes a broader view. At the beginning of the month he had an informal discussion with a group of shipbuilding trade unionists to discuss ways and means of introducing the very necessary increased flexibility and productivity in our yards, and this week he was scheduled to have had a similar meeting with representatives of the shipbuilding employers. From the Minister's meeting with the trade union representatives came the reassuring news that the latter recognized that "faults were by no means all on one side."

If there is similar news from the meeting with the employers, then there may be hope that the industry might be able to create a personnel policy and a mood appropriate to the 20th century. Given such a policy and such a mood, there is obviously plenty of life left in British shipbuilding. If this policy and mood do not appear, some more of our best shipbuilding craftsmen might be attracted to Canada and Sweden, as is already happening with Belfast shipworkers.

Indian Undergraduates in the UK

Political and Economc Planning have published a pamphlet, "Indian University Students in Britain" (price 4*s*), which sets out to describe Indian students' reasons for coming to Britain, their initial experiences, their problems in adjusting themselves to life here and the attitudes they have formed towards British people and British society.

Material for the pamphlet was obtained through a survey of a sample of 400 students at the universities of London, Oxford, Cambridge, Manchester and Leeds. Since there are more Indian students than any other single body of overseas students at British universities, and since India's industrialization is increasing rapidly, there are good social and economic, as well as political, reasons for taking note of this report. Britain might also learn something about herself from it.

The authors found it convenient to divide the students roughly into "upper" and "middle class," many of those in the latter category being postgraduates with industrial experience and some of them being married. Whereas nearly all the upper class students were being supported by their families, the majority of middle class students were being supported by loans, by their own money, by jobs in this country or by scholarships or grants.

Achieving Status

For most of the students, coming to Britain has been a major event in their lives, and their most important reasons for coming were to gain advanced training and improve their prospects. For the upper class students, the problem was to maintain their established status in society and a foreign education was one way of doing this. For the middle class student, the problem was to raise his family to a higher social position.

Experiences on arrival in this country were influenced, of course, by such factors as having friends to receive them or letters of introduction or accommodation booked in advance. Understandably, too, students who had their first accommodation in hostels or colleges tended to feel more assured than those who stayed in lodgings and hotels. A fifth of the upper class and half of the middle class students had experienced difficulties over accommodation, the most frequent difficulty encountered being colour discrimination though, perhaps, such discrimination might sometimes have been suspected where it did not exist. More upper class families visited familes—British and Indian—in this country than middle class students, 44 per cent of the latter not visiting any families at all. They had difficulty and inhibitions, too, in their relationships with girls. Emotional problems, which many students had not anticipated, were caused by loneliness, homesickness and food (especially in the case of vegetarians), and married students separated from their wives and children were under an especial strain. Finance was often another problem.

Most of the Indian students rated the British high in such social attributes as helpfulness, honesty, responsibility and discipline, but they thought them far less sincere, affectionate, kind, informal, hospitable and generous than Indians. Examples of incidents quoted by students showed how misunderstandings may arise from cultural differences. Many students, though, felt that they had gained a sense of independence and a broader outlook through their stay in Britain, and that they had developed a more critical and creative approach to their academic work.

The pamphlet recommends that overseas students should have detailed information about living and studying conditions before coming to this country, that they should have adequate financial support and that they should be able to find accommodation in a hall of residence or hostel. It also deplores the lack of contact between many of the students and life in Britain beyond the university.

Reorganization at the IEE

The Institution of Electrical Engineers have voted in support of their Council's plan for replacing the present sectionalized sections of the Institution by a divisional structure, designed to improve the Institution's handling of its activities as a learned society. Allowance by the Privy Council is necessary before the necessary changes can be written into the by-laws, but the Council are getting down to the job of preparing for the introduction of the new scheme in October, 1962, by which time it is hoped that the Privy Council authority will have been received.

Under the scheme, the present four specialized sections will be replaced by divisions for (*a*) electronics, (*b*) power, and (*c*) science and general. Each division will work through about ten relatively specialized professional groups. These 30 groups will together cover the whole range of electrical engineering and their number and coverage can be modified quickly to reflect any change of emphasis in the technologies. New researches and developments, in particular, can be followed up without delay by the formation of corresponding new groups.

Building Centre Travelling Scholarships

The Building Centre has announced a scheme of post-graduate travelling scholarships for qualified architects, structural engineers, quantity surveyors or builders who have been employed in the industry for at least two years, or who are teachers of architecture or building, or who are engaged in building research. There will be two scholarships of £250 each awarded annually, with the object of encouraging the study of building materials, equipment and processes used in other countries.

The scholarship winners need not be from the same part of the building industry, but they will undertake to travel abroad together for not less than one month in order to make a joint study of how overseas countries operate. An interesting feature of the scholarships is that the recipients' joint report, submitted on their return, can be in a form suitable for a Building Centre recorded technical talk. These talks are on gramophone records, accompanied by a film strip, and are made available without charge to societies and educational establishments.

One of the prerequisites of the awards must therefore be, of course, that the scholars are sufficiently well qualified and experienced to be able to assess the value and relevance to British building of what they see on their travels. This recognition by a leading industry of the importance of sharing and learning from experience internationally is a refreshingly broad view, which other industries might be well advised to consider emulating. No industry—like no man—is an island.

Details of these scholarships and entry forms can be obtained from the Director, Building Centre, 26 Store St., London WC1.

Tema Harbour and Township

Tema is a new port, now nearly complete, a few miles from Ghana's capital, Accra. A township on most modern lines is also being built for 100,000 people.

GHANA's new harbour at Tema, 17 miles along the coast from Accra, the capital, is among the largest enclosed harbour areas in the world. Nearly 500 acres of water are contained within the two rock-rubble breakwaters. Behind the harbour, which is due to come into full commercial operation early next year, is the township of Tema, built to be the commercial and industrial centre of the country.

The need for a new port for the country was recognized many years ago. There are no natural harbours and Takoradi, originally built more than 30 years ago, is too far from Accra to be adequate and in the wrong section of the coast if the Volta River Project, with its related aluminium smelter, is to be developed. However, the decision to go ahead with Tema was taken on the need for a deep water harbour to serve the capital and the eastern half of the country generally, irrespective of the Volta River Project (VRP) being implemented or not. On the other hand, the VRP could not be contemplated on even the smallest scale without the existence of good harbour facilities in the area.

Geographically, Tema possessed several advantages to commend it. It was close enough to Accra to relieve Takoradi of the cargo intended for the capital; constructionally it was within practical, if not easy, reach of plentiful supplies of good rock for building the breakwaters and other works; there was deep water close inshore, which reduced the dredging required; and, finally, it was strategically located for integrating with the VPR should that materialize. Also, the maximum difference between high and low water is only 5 ft.

The principal drawback to the site was the existence of a long established community of 4,000—which was a large concentration of population for the country—whose fishing beach lay within the confines of the proposed harbour. Although by any standards, the conditions in which the villagers lived were of the poorest kind, a major social problem was involved in getting the village re-established in new cottages further east where a new fishing harbour, with a sheltered canoe beach, has been provided in the perimeter of the main site.

As originally planned the harbour had four berths to handle a million tons of freight annually; but now ten berths are complete or under construction and eventually there will be 20.

The alignment of the two breakwaters—the longest is just over 1½ miles and the other just under a mile in length—was decided on the basis of extensive model tests at the Hydraulic Research Station at Wallingford, Berkshire. The breakwaters are massive structures. The maximum width on the sea bed is over 200 ft, they have a crest width of 30 ft and at the extremities are 50 ft in height; about 2½ million cu. yd of quarry-run rock were tipped during their construction. Both sides of the breakwaters are protected by a skin of armour stone; on the seaward side this consists of an 8 ft layer of blocks weighing between 5 and 10 tons each. The entrance to the harbour is 800 ft wide.

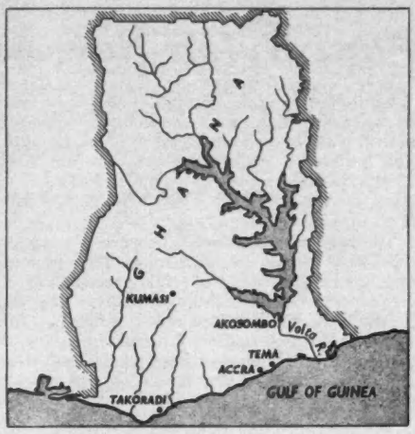
For much of the construction, rock placing in the breakwaters progressed at the rate of 15,500 cu. yd per week. Two main methods were used. Flat wagons carrying the trays of rock were shunted out along the completed spurs and a travelling crane used to place the rock in position. Alternatively, for placing the cores of the walls, hopper barges were employed and the rock dropped into position.

Inside the main harbour the first four berths were completed on a "finger" quay 1,200 ft long and 490 ft wide, the No. 2 quay. The draught available at high tide is 26 ft. To enclose the filling for this quay a retaining wall, 3,250 ft long, was built mainly of precast concrete blocks weighing 16 tons each. The blocks were placed below water in a bonded formation up to seven courses high and 10 ft thick. As many as 125 blocks were placed in a week and the whole quay of 65,000 sq. yd, and averaging nearly 30 ft in depth of fill, was completed within a 12 months period.

There are four large transit sheds—three are 460 ft and the fourth is 500 ft in length—and three acres of open storage space. The main framework for the shorter sheds is a steel portal of 85 ft span and adequate height for modern stacking trucks to operate freely; each shed has a rail platform for the whole length. The fourth shed, at the mail-boat berth, is a two-storey structure with passenger accommodation and customs facilities above and cargo storage below.

On the mainland, reclamation has involved the excavation, transport and tipping of another 2½ million cu. yd of earth and rock, much of it to form quay No. 1. Buildings include the harbour offices, a railway station and two sheds for cocoa storage. These two sheds, both 440 ft long, have among the world's largest single-span roofs, for the sheds have an unsupported width of 170 ft. There is an oil terminal on the lee breakwater.

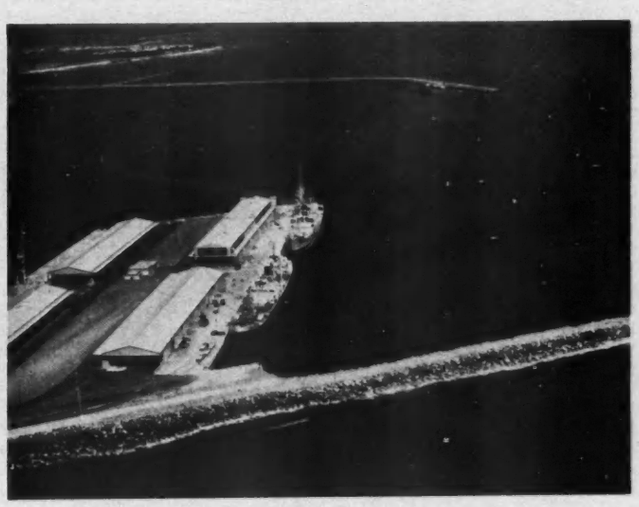
The contractors for the above work have been the London concern of Parkinson Howard Limited who secured the original contract for the breakwaters and the main pier in September, 1954. Since then they have won further contracts as work for new berths has been put to tender. They have also constructed a number of roads leading up to the Akosombo site on the Volta River. The consulting engineers have been Sir William Halcrow and Partners of Alliance House, London SW1, who were the original engineering consultants for the Volta River Project.



Tema shown in relationship to Accra and the Volta River Project based on the dam at Akosombo.

Behind the harbour, the new town is already taking shape—15 miles of main roads and 25 miles of open stormwater drainage have been completed, and so has the modern hospital and some other principal buildings. The present population is 40,000 but the plans are based on a community of 100,000 in the near future and 200,000 in 25 years. In time, it is expected that there will be 2,800 acres of oil refineries and other industrial installations. The VPR smelter, which will be at Tema, is intended to have an output of 120,000 tons of aluminium per annum.

The township is planned as seven separate areas, each comprising four neighbourhoods. Each neighbourhood will have accommodation for about 4,000, with its own primary school, churches, shops and markets. In the centre will be concentrated the administrative, business, entertainment and cultural activities. A feature of the planning is the complete separation of the pedestrians from the motor traffic, the main thoroughfares, each 300 ft wide, being laid out on 9,900 ft square grid and connected by two or three-level intersections. The whole project will provide West Africa, and Ghana in particular, with its first planned balanced community, based on a variety of industries and providing as many types of employment as is possible.



(Above) The No. 1 quay under construction; the area behind the quay wall has been filled and is now the site of the cocoa sheds. (Right) No. 2 quay completed with its four sheds, including the two-storey passenger shed.

First Nylon Nets on Multi-Storey Building

What is said to be the first nylon nets to be used in the construction of a multi-storey building are now in place at a site in Victoria Street, London. The building is an office block that will have 27 storeys and an overall height of 300 ft. The main contractor is Sir Robert McAlpine and Sons Limited.

The nets serve the double purpose of ensuring the safety of anyone who might fall from an upper storey as well as giving protection to people below against falling objects. Supplied by the London Spinning Company, the nets are 11 ft wide and carried off a tubular steel framework. British Nylon Spinners claim that large sections of the net can be easily and quickly raised as work progresses.

The 4 in mesh of the nets is made from a braided nylon cord having a breaking strength of 500 lb, while the border rope is of similar cord but having a strength of 1,200 lb.

London Spinning Company Limited, Parkside Works, Grinstead Road, London SE8.

Portable Flyover to Relieve Traffic Blackspots

Designed to solve some of the traffic jams at road junctions, the "Carbridge" is the first prefabricated and portable flyover to be built. The advantage with the Carbridge is the speed of building—complete sections of roadway, with kerbs and side barriers in place, are carried on telescopic trestles. The finished unit can be erected in a matter of days at a fraction of the cost of the conventional flyover and is strong enough to support a line of double-decker buses running nose-to-tail.

The Carbridge is built from standard steel components. It is a multi-span, through-type bridge of plate girders supporting a battledeck construction floor, and carried on telescopic portal trestles. The deck components are fabricated in 5 ft panels spanning the main girders which incoporate steel kerbs. The main girders are stiffened to withstand the impact of vehicles using the bridge.

Longitudinal rod bracing is provided between the trestles in at least one bay per 200 ft length and more frequently if the track is curved. The variation in length due to temperature differences is also catered for.

The trestles are adjustable in height in steps of 12 ft. The concrete foundations are built to give the actual deck-line and the structure is fixed down to the foundations by bolts in taper boxes. It is claimed that the design presents a clean, uncluttered appearance and if colour schemes, lighting and other fittings are carefully chosen there is no reason why the amenities of an area should be spoilt.

Short ramps, 30 to 40 ft long at the ends of the bridge, are provided by the highway authority to bring vehicles on to the ramped approach portions of the steel bridge. The carriage width is 10 ft between kerbs, and the nominal length of steel structure may be any multiple of 10 ft. Four types of main girder are used to give spans of 20, 30, 40 and 60 ft nominal length. The maximum height of the telescopic trestles is arranged to give clearance of 16 ft 6 in under the bridge in all conditions.

The design loading has been based on a train of four axle vehicles, each of 32 tons gross. The surfacing is made from $\frac{1}{4}$ in thick composition with an epoxy resin base laid on to the steel plate.

The first Carbridge was assembled at Camp Hill, Birmingham, during a weekend last month, when constructional work was completed in under 30 hours. It consists of a single 10 ft wide carriageway and includes two bends over its 790 ft length. Twenty-three sections were used, and the 48 steel erectors were assisted by to 25 ton cranes. A conventional flyover at this point would have cost about £500,000, but the total cost of the Carbridge was £80,000.

The Carbridge is designed to last 25 years but it may be taken down if it is no longer required and used on another site.

John Lysaght's Bristol Works Limited.

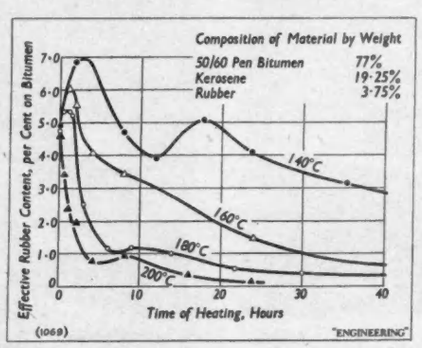
Use of Rubber in Road Surface Preparations

The inclusion of rubber with bitumen material for road surface preparations is found to produce a greater viscosity than possessed by the original bitumen, plus an increase in the elasticity. The changes are dependent on the amount and type of rubber, the temperature and time of heating, and the degree of dispersion. In general, the viscosity of a rubberized bitumen mix initially rises with time and after reaching a maximum decreases. The temperature required to produce maximum viscosity is usually between 140° and 180° C, depending on the type of rubber. The initial increase is associated with an increasing degree of dispersion of the rubber throughout the bitumen and slight vulcanization of the rubber due to the presence of sulphur in the bitumen. The subsequent decrease in viscosity is related to the degradation of the rubber.

With nearly all types of rubber there is an increase in softening and a decrease in penetration compared with the values for the base bitumen. These changes have the most effect when the rubber is added in the form of latex, and least when added as a vulcanized powder.

The effective rubber content is defined as the concentration of un-degraded rubber which must be added to bitumen to give the same specific viscosity as the test sample. It enables differentiating between the various types of binders which may be prepared with the same amount of rubber but which, through differences in the periods and degrees of heating, may finally have considerably different rheological properties.

Natural rubber used in bituminous road surfaces generally consists of one of the following: *harcrumb*, a lightly unvulcanized powder containing some 96 per cent rubber; *pulvatex*, an unvulcanized rubber powder containing about 40 per cent of infusorial as a filler, manufactured at present in Holland; *rohorub*, a powder produced in Malaya, lightly vulcanized and containing 75 per cent rubber; *latex* and *revertex*, concentrated natural emulsions of rubber containing 60 to 70 per cent rubber and 40 to 30 per cent water.



Variation of effective rubber content with time and temperature of heating.

In the preparation of rubberized bitumen, blending is by heat and agitation; the more violent the agitation and the higher the temperature the shorter the blending period required.

The technique of laying is different from that required with a straight bitumen, the stiffness of rubberized mastic asphalt generally requiring the material to be pushed into position with the float.

Research work on the use of rubberized bitumen is being conducted jointly by the Natural Rubber Bureau, the Road Research Laboratory at Harmondsworth, and the Natural Rubber Producers' Research Association. Several sites throughout the country are being used for full scale experiments with rubberized materials, and in all cases there has been an increased resistance to cracking. A report—*Natural Rubber for Research, a Review of Research and Development*—describing the joint work has been published by the Natural Rubber Bureau as Technical Note No. 3.

The Natural Rubber Bureau, 19 Buckingham Street, London WC1.

Steelwork Framework for Church

The recently completed church of St. Michael's in East Ham, London, uses structural steel roof frames to form the basis of the triangulated building design.

The steelwork comprises three-pinned portal arches, each half of the arch comprising an integral rafter and stanchion, fabricated from 12 in by

St. Michael's, East Ham.

5 in rolled steel joists. The joists were splay cut along the web, turned end to end and welded to form a tapering joist section. Both the rafter and the stanchion section form one rigid unit 15 in deep at the shoulder and tapering to 9 in at the base and ridge. This arrangement places the strength where it is most needed, and is therefore the most economical.

The general contractors for the building were J. and R. Rooff, 679 Barking Road, London, E13, and Saunders and Forster Limited, of the Chamberlain Group of Companies, were responsible for the design and construction of the steelwork.

Sanders and Forster Limited, Warton Road, London E15.

Diary System for Civil Engineers

An effective system has been initiated to maintain at the Manchester Building Centre a comprehensive diary for civil engineers. Details will include institution meetings, press conferences, film shows, lectures, exhibitions, opening of new buildings, etc. The Centre (telephone no: Manchester Central 6933) will provide a 24 hour service.

The Centre has been running a diary of building events in the north for the past six months, but in consultation with the Building Centre in London, the Building Editors' Group and the Institute of Public Relations, it has been decided to extend the service over the remainder of the country. The diary will be started at once, and the service will be free.

Third 2,000 MW Power Station for UK

Work is expected to begin early next year on the third 2,000 MW thermal power station for the Central Electricity Generating Board. The new station will be situated on the River Aire at Eggborough, about six miles east of Ferrybridge, and will have the same capacity as the new Ferrybridge C and West Burton power stations. Both Ferrybridge and Eggborough are in Yorkshire.

The main plant at Eggborough will comprise four turbo-generators, each of 500 MW installed capacity, and four boilers with an evaporative capacity of 3,450,000 lb of steam per hour. The first unit is planned to be commissioned in 1966 and the station is due for completion in 1968, a year after the completion of Ferrybridge C. When fully operational, Eggborough will burn 5 million tons of coal a year.

The main contractors are to be the Cleveland Bridge & Engineering Co. Ltd., Darlington.

London's Underground Garage in Hyde Park

The Government has authorized the Westminster City Council to begin work on the underground car park in Hyde Park. The garage is to be built for the council by Sir Robert McAlpine and Sons at a cost of £1,000,000. It will be on one floor and have accommodation for between 1,000 and 1,100 vehicles, which will enter and leave by ramps. Pedestrians will have an underground connection to Marble Arch underground station.

Excavation should begin in a few weeks and though the contract period allowed is 60 weeks, it is hoped that work will be complete in time for the Christmas rush next year. When the garage is complete, the surface of Hyde Park will have been restored for the benefit of the public.

Progress at Arabian Gulf Tanker Terminal

Constructional work is nearing completion at the deep water terminal for the largest tankers at Khor-al-Amaya in the Arabian Gulf. The terminal, which is costing £6,950,000, consists of an island about 25 miles from Fao, Iraq. It will be connected to the shore by two underwater pipelines through which oil will be piped from the Basrah Petroleum Company's station at Fao.

A centre island, 400 ft long by 240 ft wide, provides a berth on each side for one tanker. The island is designed for 65,000 ton vessels, but tankers of 100,000 tons also may be safely berthed. The island is formed by a piled structure in 75 ft of water at low water and is heavily stiffened with steel braces. At the berths there are concrete strong points carried by 32 in diameter steel tube rakers.

The centre island is connected to two mooring dolphins by a bridge at both ends which continues to the two end islands. One end island is used for tug berths, and contains large tanks for oil surge relief and foam supplies for fire fighting; the other holds most of the operating machinery for the terminal, including air conditioning plant, sea water distillation plant, spare diesel alternators and fire pumps.

The two islands are constructed with DeLong Units built as a single unit on the Tyne. The unit was towed out to the site and then cut in two. They were first used as part of the plant for pile driving during construction.

The consulting engineers for the project are Rendel, Palmer and Tritton, London SW1.

Glulam Roof Trusses at Olympia

An unusual form of glued timber roof structure will be demonstrated by Leicester, Lovell and Company Limited at the Olympia Building Exhibition. It consists of a centrally cantilevered space-frame of "lattice" construction and a series of lightweight trusses. The trusses are also of lattice construction, cantilevered from the space-frame. Both the space-frame and the trusses are fabricated from a selected grade of Douglas Fir and mahogany plywood; the majority of the timber used is not greater than $1\frac{1}{2}$ in by $\frac{5}{8}$ in in section. There is likely to be a considerable increase in the use of this type timber truss in the near future, both of the glued laminated type and with nailed joints.

The whole roof structure, which will cover the 570 sq. ft area of the stand, will be supported on a single "A" frame, each leg consisting of two members 3 in by $1\frac{1}{2}$ in section. Stability against overturning will be given by two guy ropes secured from the end of the shorter cantilever of the space-frame to the floor. In addition to its own weight, the frame will support a further 150 lb from the end of the longer cantilever. Fabrication of the roof will have been undertaken by Gabriel Wade and English Limited of Southampton.

Design of Precast Hollow Floor Units

Concrete Limited, who use the Bison trade mark for their precast concrete products, have been in the business since 1919, and they have been producing hollow precast floor units ever since. In 1948, they were the first firm in Britain to apply prestressing techniques to this type of unit. By 1958 the output of prestressed Bison units had grown to 7,000,000 sq. ft per annum.

The company's experience in design and production of precast floor units, in tendering, contract procedure, delivery and fixing, is set down in a new edition of *The Bison Information Book*, concerned only with floors and roofs. (A companion volume deals with structural precast frames, bridge beams and piles.)

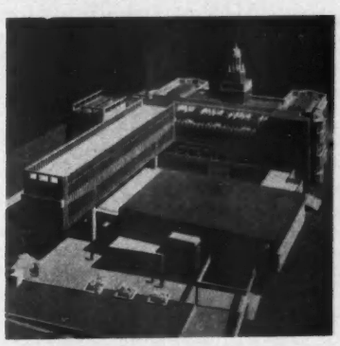
The volume is addressed particularly to the designer because "it is at the earliest planning stage of a scheme that best use can be made of the book."

Concrete Ltd., Green Lane, Hounslow, Middlesex.

Extensions to Kings College, Newcastle

To cater for the increased number of students, expected to reach 5,000 within the next few years, a new refectory and students' union extension is being built for Kings College, Newcastle. A 170 ft long "flying wing" is being constructed by John Laing Construction Limited. The project, due for completion in 1963, also includes a new south-west extension and façade to the existing union building, a ballroom and a debating chamber.

The "flying wing" will be of reinforced concrete construction, supported on four concrete columns spaced 26 ft 6 in apart and 99 ft longitudinally. These support a main beam of post-tensioned concrete running at mid-height



Model of the new "flying wing" for Kings College, Newcastle.

along the wing, and linked by precast concrete columns to subsidiary beams which carry the lower floor and roof. Thus the lower floor will be suspended from the main floorway beam. Each end of the structure will be cantilevered a distance of 35 ft beyond the columns.

With the exception of a small service tower, which will be brick built to match the existing building, external treatment will consist of exposed aggregate concrete, relief being provided by natural materials. The cladding materials were chosen for their self-cleansing properties, and to give emphasis to the new group of buildings by contrasting them with the traditional brick of the college.

John Laing Construction Ltd., London NW7.

Work and Travel in the Lands of Cold

The heroic penetration of Earth's coldest areas provided new dimensions for Man's growing needs, demanding new technologies in return.

AMONG the most renowned of challenges to discovery, the icebound areas of the world tax man's adventure and endurance with conditions of unequalled severity. At their extremes these vast wastes are often barren of natural life in any form, and unlike the tropic zones, tend not to conduce to its support, far from its luxuriation. To this is adduced the inexorable nature of the terrain itself, as much a bar to movement as frigid temperatures are to unspecialized or unprotected life, or to conventional machines, materials or methods of construction.

Here, the handicaps of snow and ice foul the land and sea approaches and to temperature factors add threats of the impassable with which tropic exploration does not have to contend, as well as its being more tolerable physiologically. Inroads into the hot areas could be made before those into Arctic and Antarctic because technical aids were not so obviously necessary for travel and existence, notwithstanding the diseases endemic in the tropics. Granted that problems of construction and power had their parallels, but the sheer forbidding of the cold lands could offer no immediate hope but of that sense of achievement associated with first penetration of inanimate masses of the earth's surface.

So it was towards the polar extremities; and the problems of exploration in itself in these regions still constitute the main task. In areas of less cold, these problems give way more to those of the beginnings and continuing development of more amenable terrain—as in the Canadian North. In these inhospitable but habitable places, long before Scott's or Shackleton's expeditions, or the advent of air communication, with survival possibilities and rescue methods now taken for granted, the fear of helpless isolation in the cold was such that in 1784 the encroachment of Arctic ice was so extensive around Iceland that evacuation of the population to the mainland of Europe was seriously debated in the Danish parliament. *The New Scientist* of 28 July, 1960, in an article by John Lear, stressed the importance of knowing how long Antarctica has been cold, and there is a growing acceptance among geophysicists that the Earth's crust slips under sufficient stress, and that the ponderous South Polar icecap has in the past pulled the crust around to turn tropics frigid and polar regions steaming—thus accounting for the Antarctic's present coal beds.

THE ICE SETTING

An ice age calendar is therefore needed if man is to do long range planning, and Professor Zeller of the University of Kansas in Lawrence has used radioactive techniques to conclude that it seems likely that the last "warm" period in McMurdo Sound was 170,000 years ago. Professor Frank Debenham, who was Professor of Geography at Cambridge from 1930 to 1949, accompanied Captain Scott's expedition to the Antarctic in 1910 and suggested that the headless remains of fish he found might have been trapped in the ice by freezing when the bottom of the ice shelf touched the sea floor and were brought to the top by successive meltings of the upper surface while new ice formed on the bottom. Recent discoveries of fish bodies on the surface of the ice shelf near McMurdo Sound would seem to confirm Professor Debenham's theory of how the ice shelf grows. Soviet measurements in Antarctica, according to Mr. Alexei Treshnikov the Soviet explorer, writing in *Pravda* on 10 January this year, indicated that the ice cap is more than 13,000 ft thick in a number of places.

Dr. Raymond J. Adie, chief geologist to the Falkland Islands Dependencies Survey, is one scientist who is on record as supporting the Gondwanaland theory—the subject of much controversy—that all the land in the southern hemisphere was once joined together in a single mass, and the continents have since drifted apart—and Antarctica today is not where it once was.

To adapt ourselves to the natural demands of the cold Earth may be the main pursuit, but in passing it is inspiring to recall a more active defiance of ice: proposals for the nuclear melting of the polar cap to ameliorate climates over the world, and the recent plan of the Soviet engineer Cherenkov for heating the "lands of eternal frost" with a ring of dust round the Earth to concentrate more solar energy here—this scheme following the suggestion of 30 years ago for Earth satellite mirrors to do the same thing, which was soon dismissed as impracticable.

THE UNCOMMON COLD

The surprising adaptability of the human body to cold was discussed by Dr. Lawrence Irving, of the Arctic Health Research Centre, Anchorage, Alaska, in *Nature* of 27 February, 1960; one of his conclusions was that "It is apparent that human adaptability to cold is of practical importance when it is evoked by careful training motivated by consideration of benefit to be obtained from exposure. It is also apparent that adaptability to cold remains a latent faculty in urban populations." The Medical Correspondent of *The Times* has commented on the body's highly efficient warming effect on inhaled cold air, and went on to point out that even the Arctic Eskimos had no special mechanism in the nose for warming breathed-in air, though they do employ a fringe of fur on the front of their headgear to trap warm expired air ready to heat the incoming stream. This must be one of the first examples of artificial adaptation.

TRAVEL AND SURVEY

Antarctica may be justly regarded as the refrigerator of the world, and it affects the entire climate and general circulation of air streams. It follows that all meteorological problems must eventually be referred to the meteorology, aerology and solar radiation of the polar continent. Again, it is now appreciated that in this polar basin, all geophysical processes are particularly apparent: the region constitutes a natural laboratory where the Earth's magnetic field, the ionosphere, and earth currents may be observed at best, to determine radio wave distribution, to draw up magnetic charts and reveal oceanographic facts. The importance of access to and travel in the area is therefore of great importance, and each Antarctic summer (November to March) the sea ice clears sufficiently for specially-strengthened ships—such as the RRS Shackleton—to make the difficult voyage to the bases with relief staff and supplies.

In the Zeiss' *Werkzeitschrift* (No. 37) Dr. H. Maelzer, describing the start of the 1959 summer campaign of the Expédition Internationale Glacologique au Groenland, gives an account of the preparation and equipment needed. A helicopter was to be carried as air freight and "there remained only little travelling space for the members of the expedition. . . . The flight went via Prestwick in Scotland and Keflavik in Iceland up to the airport of Søndre Strømfjord which is located on the west coast of Greenland above the polar circle. The latter place served as the starting point for the expedition. Fourteen motor vehicles with caterpillar tracks, eight sled-trailers, seven transport sleds, the entire food supplies, and a large amount of the technical material and equipment had been transported to Søndre Strømfjord by boat as early as the fall of 1958."

Specialized vehicles are obviously necessary for efficient travel across snows and glaciers. In a paper written for presentation to the Automobile Division of the Institution of Mechanical Engineers on 14 April, 1959, Mr. D. L. Pratt, M.A., A.M.I.Mech.E., surveyed "The Performance of Vehicles under Trans-Antarctic Conditions," with especial respect to the 2,158 mile vehicle journey made for the first time across the Antarctic Continent from the Weddell Sea to the Ross Sea in the summer of 1957-58. The scheme involved considerable research into mechanical equipment for low temperature operation and led to the development of suitable vehicle systems. Vehicles were essential to carry the necessary weight of equipment for the scientific programmes and especially that of the seismic traverse of the continent, and much dependence was placed upon mechanical transport.

To counter the treacheries of the ground, a Weasel tracked vehicle was fitted with a crevasse detector in leading the US Army Transportation Corps tractor train during an expedition in previously unmarked danger areas on the Greenland Arctic Cap. This device was electronically operated and sounded a warning when one of its bowl-shaped structures, rigged out in front of the vehicle, passed over a cleft in the ice.

For light sea craft in the cold waters, outboard motors have been used successfully—a Perkins 6 hp type powered a 14 ft whaler with the St. Andrews University South Greenland Expedition. A 12hp Petter Avazrmr air-cooled marine diesel was fitted to the 25 ft work boat of RRS Shackleton for service on this year's Antarctic tour; this provision was to eliminate the possibility of ice clogging the cooling system as occurs with a water cooled type of engine, and also to give the improved engine wear expected with higher engine temperature.

Engine starting is a very real problem: the Bendix Corporation of America have developed a system to start diesels in Arctic temperatures below —40° F by burning fuel in the intake manifold, and Petters Limited are now able to offer standard production engines which start down to —40° C with special attachments and satisfy Admiralty and Air Ministry requirements. On occasion extremely low temperatures defy all measures, and Australia's scientific expedition in the Antarctic encountered temperatures of 100° F below zero: glycol anti-freeze compound itself froze and halted progress until thawed out.

The unbroken voyages beneath the polar ice by US nuclear submarines are now legendary; earlier this year two British submarines were reported to be testing new navigational equipment under ice in the Arctic Circle.

MATERIALS AND TECHNIQUES

The demotic image of building in frigid zones has always included the igloo—and this is far from being without well-learnt precepts of the facts of cold, with its use of ice blocks for strength and insulation, a use since taken up on polar sites in the construction of more elaborate camp facilities underground. The Division of Building Research, National Research Council, Ottawa, found last year from its research that thin insulation which included air spaces in the wall cavity was generally not suitable for northern service, while bulk type insulation was considered more reliable, the long term problem of condensation in the wall being overcome with the help of large sheet vapour barriers in the form of such materials as polyethylene.

Mr. C. R. Crocker, Senior Research Officer of the Division of Building Research in a paper given in 1959 spoke of the extension of the building season which has been possible in Canada due to advances in winter construction techniques. He attributed much of this progress to the development of new materials and equipment

to enclose a project and control the climate within the enclosure to ensure ideal conditions—most of these enclosures being plastic films. "Steel-frame buildings have the advantage that the structural steel may be erected in all but the most severe weather" Mr. Crocker pointed out, and again: "Reinforced concrete frame buildings require more care, in that provision must be made to protect the concrete columns and beams until they have attained the desired strength. Precast concrete is being used to overcome some of these difficulties."

It is of interest to note his observation that wood-frame construction, widely used in residential buildings, is not affected by cold weather and is often better in quality in winter when not subject to the rain of the warmer season. Mr. Crocker and Mr. A. W. Smith, Junior Research Officer, Division of Building Research, had made the point in a joint paper given in June, 1959, that the solution of using precast concrete in the Canadian winter was hampered by lack of experience of the technique in that country, whereas in Europe, precast concrete had been widely used for many years, and experience there indicated a favourable outlook for the practice in Canada once some practical difficulties were overcome—the most serious being making connections between members.

HAZARDS BELOW ZERO

Under conditions of very low temperature, the risks which have to be faced by humans, machines and materials are sometimes fairly clearly anticipated, but there are occasions when there is a surprising turn of events. At one time it was thought in medical circles that Arctic conditions would provide excellent sanatoria, and that ambient air and materials, being devoid of bacterial or viral infection, would make for healing and for prophylaxis. It therefore came as a shock when it was learned that a member of the Australian expedition, which arrived back in Melbourne in the polar ship "Thala Dan" on 19 March, 1960, had contracted a mild form of poliomyelitis at Mawson. Doctors believed this to be the first case of virus infection in the Antarctic.

Fire constitutes another unexpected hazard in the Antarctic. Conflagrations at bases in these very cold regions can be as catastrophic as those at sea; additional causes can abound in that buildings are often of wood, air is dry and high winds prevail; no water is available and foam and chemical extinguishers are useless because the mixtures used freeze at —10° F. This kind of setting promoted the fire at the USSR's principal Antarctic base at Mirny in July, 1960, and other similar disasters have affected the French and Argentinian bases—the French thereafter contemplating aluminium housing structures. Fire damage to equipment and buildings at the US base on Ross Island, McMurdo Sound, was estimated at £700,000.

The treacherous foundations of ice themselves are responsible for many losses, as may be imagined; and in the early part of this year nuclear power station parts, vehicles and other equipment were lost at the US McMurdo Sound base when the ice broke up during a 60 mph blizzard. The constant vigilance needed to prevent structural damage to machinery is well demonstrated by experience at the Soviet inland Arctic Research Station at Vostok. At temperatures when diesel fuel becomes a sticky mass and metal brittle, the bed plate of a main diesel generator cracked and threw the station on inadequate emergency supplies. After welding the crack, an additional heating system was installed in the foundation of the generator to prevent a recurrence.

POWER PROVISION

The advantages of low temperatures for storing organic substances, including foodstuffs, have to be countered at times, as with the plant being constructed by Rustyfa Limited, a consortium of British firms, at Dnepropetrovsk, to thaw frozen bales of natural rubber by radio frequency.

Constant supplies of power represent a readily grasped problem in the remote wastes, and nuclear plant immediately occurs to mind as an ideal solution. The US Atomic Energy Commission invited proposals for a packaged nuclear power plant for the McMurdo Sound base in June, 1960. The specification was for the design of a 1,500 kW (electrical) reactor; fabrication, assembly and testing of components; and erection and test operation at site. It was also laid down that the reactor should be moderated and cooled with light water, and should be of the pressurized or boiling water type. It was planned to have the reactor tested and ready for shipment by November this year and in operation by early 1962, to provide maximum time for construction during the short Antarctic summer season. In August, 1960, it was announced by the AEC that they were to negotiate a contract with the Martin Company for this installation at not more than $3,950,678.

A proposal for an Arctic grid drawing hydroelectric power from the four northern rivers in the Kola Peninsula and Karelia, was made last year under the USSR's 20 year plan, to provide current for the Soviet North-West. Two stations were planned to be ready by 1965; these would be built on tributaries of the River Kovda and followed by a series of stations on the Ponoe and the Voronya rivers. These stations would supply some 3,500 million kWh per year, and another 1,500 million kWh would come from a similar chain to be constructed by 1970 on the River Kem.

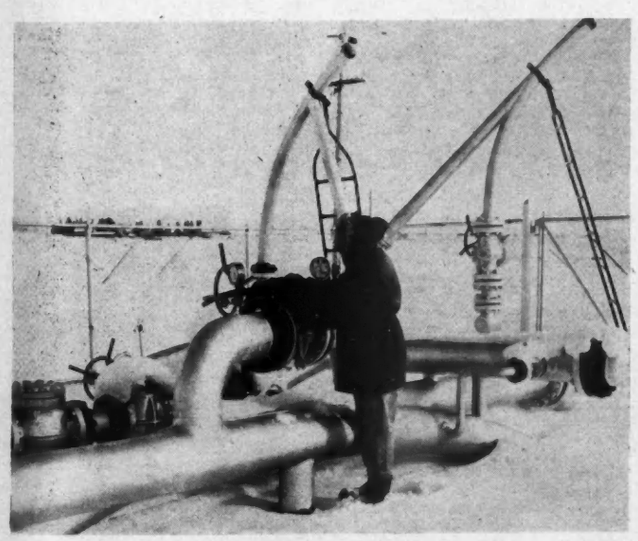
FUTURE OF RESOURCES

In a world of insatiable requirements for living space and the modern means to live, the opening up of these great cold tracts—especially of the hitherto untouched and still largely unknown polar Ultima Thule—becomes a matter of increasing urgency.

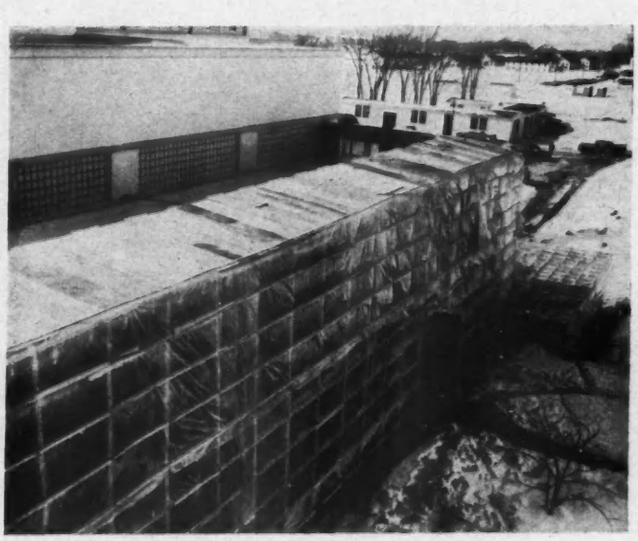
The Institute of Petroleum in January this year heard a paper by Mr. A. Bryce Cameron, of Lobitos Oilfields Canada Limited, on the Queen Elizabeth Islands of Arctic Canada and their petroleum prospects. In this, it was submitted that these islands possessed a great variety of geological formations with abundant signs of petroleum substances; there were many large closed structures similar in size to those in the Middle East; geological field work has supported photoanalytical and photogrammetrical studies. It was estimated that a programme of continuous drilling throughout the year might cost $2,000,000, with a proportionately reduced expenditure if no mid-winter operations were conducted. It was suggested that all the equipment necessary could be shipped from Great Britain. Rapid development might be expected, with some oil being exported by tanker direct to West European and East Canadian markets within a year of discovery.

Mr. G. de Q. Robin, writing as the Director of the Scott Polar Research Institute, Cambridge, on Future Antarctic Research (*The New Scientist* of 5 March, 1959) looked forward to a rapid closing of the persistent gaps in knowledge, particularly in the meteorology of Antarctica, in observations on geomagnetism, aurorae, the ionosphere and those on cosmic rays from that continent.

Fifty years ago, on 14 December, 1911, Amundsen arrived at the South Pole: a reminder that the heroic deeds of the great explorers blazed the trail for expanding as well as curious humanity; many less constantly icy lands have been opened up already by an age made bolder by its developed capacity: Alaska has its way; others, more confidently curious than the first explorers, now reach out with the exploiting arms of science and technology to make the lands and waters of the ice of service to man in the true continuation of the first conquests.



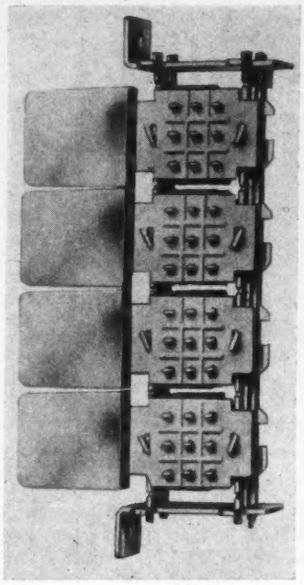
(Left) Newman-Milliken valves, produced by the Newman, Hender Group, on natural gas service at sub-zero temperatures in Alberta, Canada. These valves are the lubricated parallel-plug type, designed to operate in extremes of temperature without jamming.



(Right) A plastic-enclosed shelter constructed for the Building Research Centre Extension at Ottawa, Ontario, Canada. Protective structures of this kind are widely used to permit such procedures as concreting in very low temperatures.

MINIATURE PUSH-BUTTON SWITCH

Alternative Actions

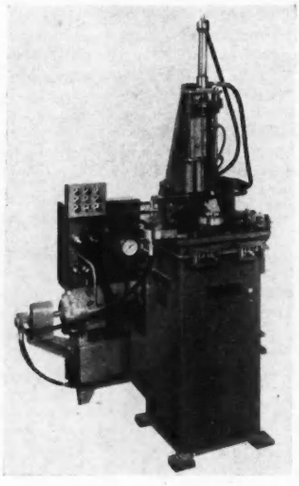


A MINIATURE push-button switch is available with from 1 to 12 buttons. Each button can provide up to 6-pole changeover switching a side, giving a possible total of 12 poles per button. Three alternative button actions are available. In the simple push action no latching is provided. With the push release action any button is held in position when pressed and is released by pressing any other button. If required an over-riding cancelling button may be fitted. In the push-push action, the button remains in position when pressed and is released by pressing a second time.

Pitch of buttons is 0·700 in. Contact rating is 150 mA at 250V r.m.s. non-reactive load. The continuous contact rating is 5A r.m.s., and the insulation resistance better than 500 MΩ at 500V dc. The switch is available for standard chassis mountings or for printed circuit applications and is suitable for domestic radio receivers, tape recorders or small industrial equipment. *Plessey Company Limited, Ilford, Essex.*

AUTOMATIC BROACHER

Loads on Return



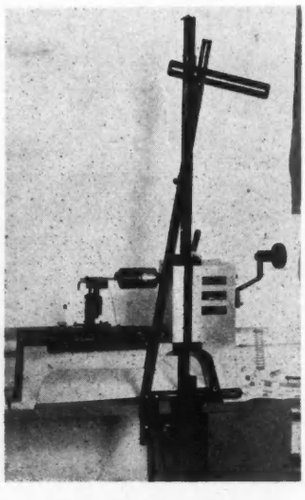
WHAT is claimed to be the first fully automatic small broacher has been added to the SPD7/16 range of pull-down broaching machines.

Known as the SPD7/16A Model, the new machine is claimed to be easily loaded during the return stroke, a feature rendered possible by the inclusion in the machine of a shuttle table taking work-holding fixtures for locating the components. A further characteristic is the additional work holder pot container, fitted into the side of the platen to allow the assembly of six components at a time into a work holder pot, which is positioned in the work holder during the return stroke. Use of two pots enables loading and unloading of the spare pot during the cutting stroke. The broach lifter is adjustable to different strokes.

Manual control of the hydraulic circuits is by push buttons. The electric circuit is interlocked so that the shuttle table cannot be moved unless the broach is at the end of the stroke. The capacity is 7,000 lb, stroke 16 in, maximum length of broach 21 in, and cutting speed from 5 to 15 ft per minute. *Lapointe Machine Tool Company Limited, Otterspool, Watford, Herts.*

HAND-OPERATED SPRING COILER

Rapid Production



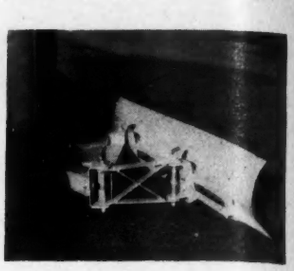
THE Carlson hand-operated spring coiler is available in two sizes, one able to wind wire from 0·004 to 0·063 in, and the other from 0·041 to 0·156 in in diameter.

It is claimed that from 250 to 400 compression or 200 to 300 extension or torsion springs can be coiled in one hour. Setting up is stated to normally occupy less than 5 minutes. Compression, extension, and torsion springs of various forms are said to be within the tool's capacity.

Spring diameter is determined by mandrels, cams control the pitch, length and squareness of the ends, and adjustable stops govern the length. Accessories supplied with the coiler include 29 mandrels, covering diameters from $\frac{1}{16}$ in to $\frac{1}{2}$ in. The smaller machine will produce springs with an od of up to 1 in, pitch up to 1 in, and a length up to 4 in. Capacities of the larger machine are, od 2 in, pitch 1 in, and length 8 in. Left-or right-hand springs may be wound. The smaller coiler weighs 35 lb and the larger 100 lb. Baseplates are 4 in by 18 in and 6 in by 23 in. *Bennett Tools Limited, Arthur Street, Redditch, Worcs.*

CALFDOZER BLADE

For Levelling or Excavating



STYLED the Powerdozer, this blade with ancillary equipment is intended for use with the Massey-Ferguson 35 tractor.

The blade, 5 ft 6 in in width, has alternative pitch angles and is reported to be quickly interchanged for excavating or levelling work. Offsetting is possible by up to 2 ft on either side. Angling is accomplished by means of a single detachable gate, which allows angles of up to 30° on either side. Tilt is infinitely variable within a range of 25°. Manufactured from material $\frac{1}{4}$ in. thick, and having a depth of 18 in, the blade is provided with a high-carbon steel reversible cutting edge.

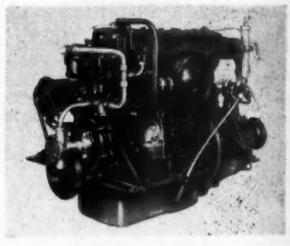
The carrying brackets, which are bolted to the front and mid-mounting pads can if desired be left in position on the subframe as, it is reported, they do not interfere with the normal operation of the tractor. Less than one minute is claimed to be required to detach the blade and frame assembly, accomplished by removing three pins.

Power is provided by a double-acting hydraulic ram, mounted alongside the engine. Positive penetration is said to be ensured at all times, as the ram instantly applies weight from the tractor to the cutting edge. The alternative angles of pitch are 45° and 70°. The maximum lift above ground is 19 in and penetration below ground 4 in.

A Utility version of the Powerdozer is available; this has powered lift and gravity drop provided by a mechanical link to the tractor lift arms. The Utility is claimed to be applicable to all work where powered penetration of the blade is not required. *Bomford and Evershed Limited, Salford Priors, Evesham, Worcestershire.*

MARINE ENGINE

Various Suitable Applications



AMONG recent additions to the range of Newage-BMC marine engines, the Captain, illustrated, has a cc of 1·5 litres.

Claimed to have low levels of vibration and noise, this diesel engine produces 32/34 bhp at 3,000 rpm. It is said to be suitable for small cruisers and pleasure craft, as an auxiliary in sailing cruisers, and as a power unit in work boats and service launches. Cylinder bore is 73 mm and stroke 88·9 mm. Speed range is 500 to 3,500 rpm. At 1,000 rpm the maximum bhp is 11 and the continuous bhp 10; torque, measured in lb·ft, is respectively 57·6 and 52·5. At 3,000 rpm maximum bhp is 34 and continuous 30·8; applicable torques are 59½ and 54 ft-lb.

A positive displacement water pump, with a neoprene impeller, is intended to have a long life in sand- or silt-laden water. Cooling is by a direct sea water system, controlled by a thermostat and incorporating a pressure relief valve. Injection is by a CAV distributor-type fuel injection pump. A Lucas 12V solenoid-operated starter and dynamo with automatic voltage control is provided. The reverse gearbox gives a straight through drive in the forward direction and through constant mesh gears and layshaft in reverse. Reduction gears of 2 : 1 and 3 : 1 are available; two-gear and three-gear patterns are offered so that handed propellers can be used. Ability to swing the reduction gear round the crankshaft centre-line in steps of 45° facilitates installation. Propeller thrust is taken by a bearing at the rear of the reverse or reduction gear case. *Newage (Manchester) Limited, Crossley Street, Manchester 18.*

TWO-TON DUMP TRUCK

All-Wheel Drive

POWERED by a Petter PH2 16·4 hp twin-cylinder diesel engine, this truck has drive to all wheels.

The two-part chassis is claimed to give equal power distribution to all wheels under all conditions. It is said that this construction also allows the skip to be positioned while stationary or moving, gives tighter turns and more accurate positioning. Hydraulic steering is reported to reduce maintenance and allow operation in conditions which would otherwise be impossible. Power is transmitted by an enclosed chain to the rear wheels and by a propeller shaft to the front pair.

Maximum payload is 2 tons. Capacity: water level 36 cu. ft; struck off 42 cu. ft; and heaped up 54 cu. ft. The loading height of the skip is 47 in. Overall length of the dumper is 9 ft 9 in, and width over wheels 5 ft 7 in, over body extreme width is 6 ft 4 in. The nett weight is 32 cwt. Speeds are 3·25 mph in first gear, 5 mph in second, and 9·8 mph in third gear. The turning radius is 12 ft 6 in. Fuel tank capacity is 3½ gal.

Operation of the skip, which is manufactured from $\frac{1}{16}$ in mild-steel plate, reinforced, is by a hydraulic double-acting ram, the rate of discharge being under control. The hydraulic pump is built into the engine; all hydraulic arrangements are protected by filters. The tyres are 7·50 by 18. Girling expanding brakes are fitted on all wheels, which are mild-steel pressings, 16 in in diameter, secured by 5 studs.

Optional extras include quarry skips, and a skip having a narrow discharge lip. *Thwaites Engineering Company Limited, Cubbington, Nr. Leamington Spa, Warwickshire.*

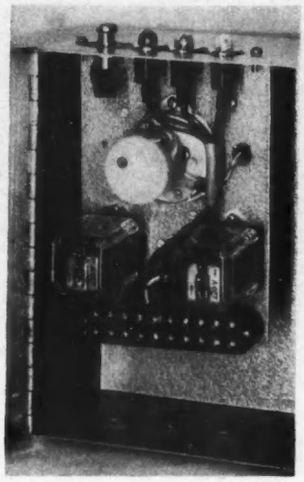
FLAME FAILURE CONTROL UNITS

For all Oil Burners

PHOTRONIC oil burner sequence and flame failure controls are stated to comply with the latest BSS and to be suitable for all types of oil burners.

All the units in the range operate on the same principle, which is that of a synchronous motor and cam system working in conjunction with a photo-resistive type of photocell. No bi-metals or valves are employed in the circuit; this arrangement, coupled with the use of sealed plug-in relays, is claimed to ensure long life with minimum attention.

In the event of flame failure a sequence of operations is automatically initiated; if the flame has not been established during the flame-establishment period—which can be varied—ignition ceases and the unit will go to lock-out. Establishment of the flame is recorded on the photocell which maintains the supply to the burner motor and duly de-energizes the ignition. If the thermostat calls for heating to be discontinued, or should the flame fail for any reason, the burner motor is immediately de-energized. Power consumption is 35W. *Photronic Controls Limited, The Lodge, Randalls Road, Leatherhead, Surrey.*



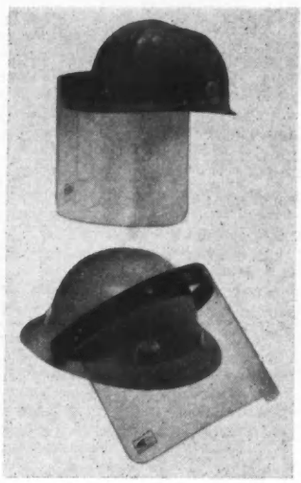
HARD HAT AND FACE SHIELD

Combined

TWO models are offered of a combined hard hat and face shield. One of these is a peak-style hat and is known as the VA/1, the other has a full brim and is styled the VA/2.

The VA/1 is available in either plastic or Fibreglass. The wrap-round face shield, which is detachable, consists of a vizor manufactured from a cellulose acetate. The material has a thickness of 0·060 or 0·080 in and a depth of 8 in. The vizor is attached to the top band, of vulcanized fibre, by bayonet slots which are claimed to give complete security against accidental removal. The band is fixed to the hat by a plug-in plastic recessed block which slides into a socket riveted to the hat. The block is retained in position by a spring catch which is reported to provide easy removal without possibility of becoming caught.

Model VA/2 is available only in plastic. Vizor and band arrangements are the same as those of the VA/1, but connection to the brim is by means of a cleat which permits swivelling.



Plastic models are white, grey, and yellow; the Fibreglass version is in various colours. *Safety Products Limited, Holmethorpe Avenue, Redhill, Surrey.*

EXTRACTION HOSE

Handles all Lightweight Solids

MACDUCT heavy duty flexible dust extraction hose is constructed of $\frac{1}{16}$ in thick abrasive-resistant rubber, with a helix of high-tensile steel wire. There is an outer ply of rubberized canvas.

It is claimed that this hose can economically handle all light solids such as sawdust, wood chips, and abrasive grindings at the usual operating pressures or at up to 20 in wg of vacuum dependent upon the hose diameter. As will be noted from the illustration, the hose is extremely flexible; it is reported that it may be flexed round a bend of $\frac{1}{4}$ in radius without significant loss of cross-sectional area. Manufactured in standard lengths of 20 ft, the hose has no cuff ends and is said to be cut to any desired length without difficulty. Connection is by worm-drive clips. If required cuff ends can be supplied as an extra.

Diameters available are from 2 to 6 in by increments of $\frac{1}{2}$ in, and 7 in and 8 in. Weights per 20 ft length are as follow: 2 in diameter 11 lb; 3 in 17 lb; 4 in 21 lb; 5 in 26 lb; 6 in 32 lb; 7 in 38 lb, and 8 in 44 lb. *George MacLellan and Company Limited, Glasgow Rubber and Asbestos Works, Glasgow NW.*

CENTRIFUGAL ALL-PURPOSE PUMP

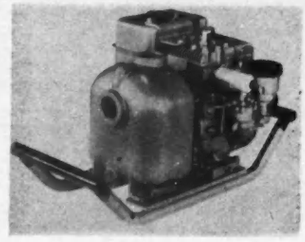
Self-Priming

THE Pomona general purpose pump is an addition to the makers' range of Pep-Loewe centrifugal pumps.

Compact, the unit is easily portable, weighing 66 lb complete. The semi-enclosed impeller is said to be unaffected by mud, sand, or other dirt and pumping is reported to be possible with solid particles up to $\frac{1}{4}$ in diameter present in the water. Power is supplied by either a 3-phase 240/415V motor or a 4-stroke petrol engine (illustrated) with recoil starter.

Once the pump casing has been filled priming is stated to be automatically assured on lifts up to 23 ft, even without a foot valve.

With the electric motor developing 1·5 hp and running at 2,800 rpm, the capacity is 3,300 gph against a total head of 43 ft, 2,640 against 44 ft, 2,000 at 48 ft, 1,320 at 51 ft, and 660 gph at 54 ft. Powered by the petrol engine, developing 2·5 hp and running at 3,600 rpm, outputs are 3,300 gph with a total head of 49 ft, 2,640 against 56 ft, 2,000 at 66 ft, 1,320 at 79 ft, and 660 gph when the total head is 89 ft.



Mounted on a tubular frame, the unit when equipped with a petrol engine has dimensions of 25 in × 12 in × 14 in. Electrically powered the overall measurements are 28 in × 11 in × 11¾ in. Pipe connections are 1½ in in diameter.

The fuel consumption of the petrol engine is reported to be 0·26 gph. Capacity of the fuel tank is approximately 0·65 gallon. Suggested uses include pumping bilge and deck washing on motor and fishing vessels. *Precision Electrical Products (Stockport) Limited Progress Works, Cale Green, Stockport Cheshire.*

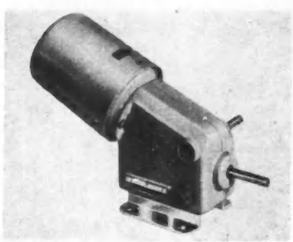
VARIABLE TRANSMISSION

Wide Speed Ranges

THE RZG variable gearing unit has output torques varying from 21 lb-in at 10 rpm to 1¼ lb-in at 300 rpm.

Claimed to meet the need for a compact variable transmission, the assembly incorporates a 50W input shaded-pole motor, which can be wound to suit any voltage from 6 to 260 ac; if reversing is required a capacitor motor, Type 35GK, can be fitted. The mechanical stepless drive provides speeds of from 110 to 1,700 rpm at the end shaft. A low speed shaft, located transversely in the transmission casing, is available as is also additional reduction gearing.

The model illustrated has low-speed shaft speeds of 3 to 235 rpm. If the transmission unit is fitted with a Type ALS additional reduction gear, the end-shaft speeds remain as quoted but the low-speed shaft speed ranges from 0·1 to 33 rpm. Equipped with a Type ALSS additional reduction gear speeds are from 0·0013 to 3·35 rpm. In the case of the normal transmission the low-speed shaft has a range of 5 speeds within the limits mentioned, in the case of the Type ALS gear 12 speed ranges are provided, and with the Type ALSS gear 8 speeds are available.



Both motor and gearbox are reported to be suitable for continuous operation. An indicator dial is built into the unit for reference purposes. It is suggested that the unit is suitable for laboratories, electronics, chemical use, and applications where accurate speeds and compactness are necessary.

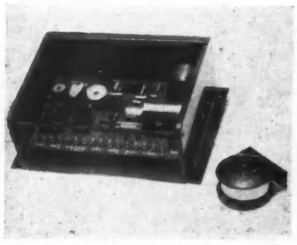
The length of all models is 205 mm over casing, the height is approximately 160 mm. Width over motor is 80 mm. *Jones and Stevens Limited, PO Box 35, Eastern By-Pass, Oxford.*

FIRE AND INTRUDER ALARM

Ultrasonic

CONTAINED in a small case, the Sonalarm ultrasonic fire and intruder detector is fully transistorized.

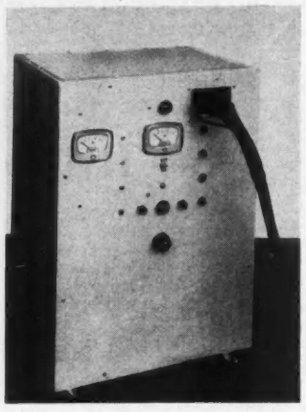
Advantages claimed for this device are ability to dispense with wiring of windows and doors, detection of movement within the premises even when no break in is involved, and complete coverage of an area of approximately 3,500 sq. ft by one unit. Each master unit works in conjunction with a minimum of two and a maximum of four transducers (one of which appears in the illustration), divided between transmitting and receiving. Ultrasonic sound waves build up a wave pattern in the room, warehouse or other premises to be protected, and the returning echoes are received by the unit. Normally the instrument is retained in a condition of balanced immobility. Should any movement take place, or fire break out, the standing wave pattern is disturbed, causing the contacts of an electrical relay to close and give an alarm.



Although the equipment is electrically operated, severance of the mains supply will not put the detector out of action: a battery, normally on charge takes over when the usual supply is cut off and, should the mains supply fail to be reconnected, after several hours an alarm will be sounded. In order that the detector will not be set off by cats or mice a sensitivity control is incorporated. An automatic sensitivity control is also embodied as the level of sensitivity required in a warehouse filled with goods differs from that prevailing when the premises are empty or partly empty. *Electronic Laboratories (Hendon) Limited, 170 Granville Road, London NW2.*

STABILIZED POWER SUPPLY UNITS

High Voltage



THREE high voltage high current stabilized power supply units have been introduced, covering a range of from 0 to 5,000 V, with a current of up to 500 mA.

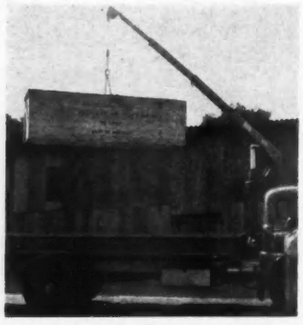
All of these units are reported to have an output voltage continuously variable with a single control from OV to the full rated voltage. Output voltage is said to vary less than ± 1 per cent for full load change. Full output current may, it is claimed, be taken down to 5 per cent of full output voltage. The ripple content is given as less than 1 V rms. The high voltage circuits are isolated from earth and may, it is reported, be run up to 10 kV above it.

The units are offered with the following ranges; 0 to 1 kV, 0 to 2 kV, and 0 to 5 kV. They are supplied for either single or three phase input.

Either mercury vapour or semiconductor rectifiers can be supplied in the highest power unit, depending upon the application. Selenium rectifiers are used in the other units. In the case of the 0 to 5 kV model, the series valves are protected either by a motorized variac, or by a saturable reactance operated by a transistorized amplifier. The latter enables control to be at the same speed as that of the 0 to 1 and 0 to 2 kV units. *Electronic Machine Company Limited, Mayday Road, Thornton Heath, Surrey.*

LORRY CRANE

Incorporates Power Winch



THE Tico Model K52E lorry crane is hydraulically operated. The telescopic boom, which is power retracted, gives loading lengths from 4 ft 3 in up to 13 ft, with capacities of 2,500 lb at 7 ft, 1,700 lb at 11 ft, and 1,300 lb at 13 ft.

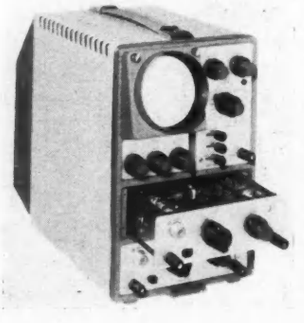
Incorporated in the boom is a power-driven winch, which enables loads to be hauled in from inaccessible sites or pulled up a loading ramp. The winch holds 131 ft of cable; loads may be lifted or lowered down to 120 ft. The ability to swing the boom through a full 360° continuously in either direction is claimed to obviate the need for careful location of the vehicle. It is reported to be possible to raise the boom to an almost vertical position 23 ft above ground level. Safe working is contributed to by an anchor rod controlling the boom action.

Operation is by a single lever manipulated from either side of the truck. Placing the lever in the neutral position has the effect of locking the crane. It is said that only 12½ in clearance is required between the cab and the body in order to accommodate the unit, which is centrally clamped on the chassis. Power is provided by a hydraulic pump, which is driven by a power take-off from the vehicle.

Use is not confined to ordinary road transport vehicles: it is said that the crane is suitable for use on barges, tractors, and other means of transport. *Colchester Tillage Limited, Hythe Hill, Colchester, Essex.*

OSCILLOSCOPE

Uses Alternative Amplifiers



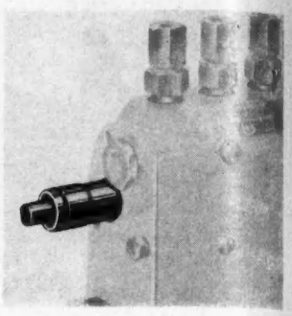
THE D33 double-beam oscilloscope is an addition to the makers' range of Serviscope equipment.

Replacing the former Model S31, the new unit is reported to give improved writing speed, wide bandwidth, and high gain facilities. The PDA tube, operating at a voltage of 3,500, is claimed to be a feature of the unit. Having alternative plug-in amplifiers the new instrument is said to possess a wide range of applications. Any of the basic series of amplifiers can be supplied or special units can be built to requirements. Of the basic range, the general-purpose amplifier is said to have wide frequency response and, if required, × 10 sensitivity over a limited bandwidth. This amplifier is reported to have many uses, especially in servo computer, television and radar development and maintenance. The differential amplifier is claimed to give high gain; maximum sensitivity is 1mV/cm dc and frequency response 200 kc/s. This unit renders the D33 model suitable for work in the electro-mechanical field, and medical and biological applications. An ultra-high-gain amplifier has maximum sensitivity of 100 μV/cm ac; frequency response is 5 c/s to 150 kc/s. It is intended primarily for use in the electro-acoustical and magnetic recording fields.

Dimensions are 7½ in wide, 12½ in high, and 16½ in long. The weight is 33 lb. Accessories include a high impedance × 10 divider probe and camera attachment. *Telequipment Limited, 313 Chase Road, Southgate, London N14.*

EXCESS FUEL DEVICE

Tamper-Proof



WHILE providing a means of obtaining excess fuel for starting purposes, the CAV excess fuel device cannot be locked in any position which will allow excess fuel to be fed under normal running conditions.

Claimed to be tamper-proof, the unit is sealed to afford evidence should any unauthorized adjustment be attempted. It is said that the unit can be fitted to all CAV in-line type fuel injection pumps, with pneumatic governors and is readily applied to units in service, in place of an existing maximum fuel stop or excess fuel device.

Under normal operating conditions a trigger plate assumes a position where a lug upon it serves as a maximum fuel stop. When the plunger is depressed movements are initiated which ultimately cause the control rod to move to the excess fuel position. Spring pressure on the trigger plate tends to return it to the normal running position and, after the engine has started and the control rod is disengaged from the trigger, the trigger plate resumes its normal position and its function as the maximum fuel stop. It is reported that the device will provide a maximum fuel stop at 8 to 16 mm control rod opening, and will allow 6 mm additional travel beyond the maximum fuel position for starting. Adjustment of the maximum fuel setting is effected by a threaded bush, which is sealed after setting. The seal is a pressed-steel cap which can not be removed without leaving evidence of tampering. *CAV Limited, Acton, London W3.*

TOWER CRANE

Static or Travelling

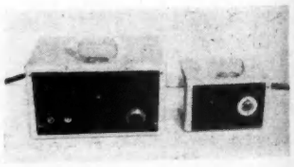
THE Pingon Model P120 tower crane is of saddle-jib design with counter-jib assembly and is arranged for full-circle slewing. It has a maximum safe working load of 10 metric tons.

The standard crane, designed for free travelling on a rail track of 19 ft 8¼ in gauge, has a maximum height under the hook of 164 ft 8 in. Used as a static unit, with fixing angles embedded in concrete and anchored to the side of the building, the maximum height obtainable under the hook is 328 ft 2 in. It is reported that the crane can be converted to a climbing one without any great modification. The mast is extendable by increments of 18 ft 4½ in. The maximum working radius is 114 ft 10 in and the minimum working radius 10 ft 8 in. With a jib having a length of 119 ft 5 in, maximum safe working loads in metric tons are: 10 at 39 ft 4 in radius, 7 at 54 ft 1 in, 5 at 75 ft 6 in, and 3 at 114 ft 10 in. Jib sections may be assembled to give jib lengths of 119 ft 5 in, 96 ft 5 in, and 73 ft 6 in.

Working speeds are: hoisting 158 and 56 ft per min, slewing 0·82 rpm, traversing 125 ft per min, and travelling along the rail track 69 ft per min. As an alternative to the travelling base mounted on four bogies, a rail-mounted portal type base is available. This gives headroom for vehicles to pass under it. The crane is a self-erecting one; when components are in position no additional craneage is required. *George Cohen 600 Group Limited, Wood Lane, London, W12.*

TRANSISTORIZED TIMING DEVICES

Versatile



TWO new fully-transistorized timing devices are announced. Intended for use with the makers' range of spot-welding guns, it is considered that these units may also be applied to other equipment not at present electrically timed, or for other applications where accurate timed switching is required.

The time cycle of both units, styled Marks II and IV, is from 2 to 50 cycles; it is determined by the discharge of current from a low-loss storage capacitor into the base of a switching transistor. A variable resistor determines the duration of the current discharge.

With a 210/250V input the Mark II, used with the makers' S15 and S20 guns, is designed to switch a line current of 30A. Initiation is by closure of low-voltage contacts in the microswitch. Accuracy is reported to be ± 1 cycle with a ± 10 per cent mains variation.

The Mark IV, the input of which is 240/415V, is used in conjunction with the manufacturers' S80 11kVA and S120 24kVA guns. It is intended to switch line currents up to 100A. Closure takes place in a manner similar to that of the Mark II unit. Accuracy, in the case of the Mark IV, is ± 1 cycle or 1 per cent, whichever is the less, independent of a mains variation of ± 6 per cent.

Operation of the time cycle is determined in the case of both instruments by the discharge of current from a low loss storage capacitor into the base of a switching transistor. The duration of the current discharge is determined by a variable resistor and is limited by a fixed resistor.

Both timers are provided with sockets to take plugs on the floating 20 ft leads of the welding guns for which they are specifically intended. The Mark II unit measures 8½ in × 6 in × 6½ in and the Mark IV 12 in × 8 in × 9 in. Weights are respectively 7 and 15 lb. *Portable Welders Limited, Castle Mills, Buckingham.*

Companies

Shipbuilding Firm's Good Year

PROFITS of AUSTIN AND PICKERSGILL LIMITED, Southwick, Sunderland, before taxation, for the year ended 30 June last were a record and amounted to no less than £591,700, compared with £426,700 for the previous twelve months. But, as their chairman, Mr. J. H. King, points out, the 1960-61 profits carry with them a tax charge of over £309,000 and that is also a record !

The firm have transferred to their capital reserve the sums of £450,000 from their general reserve and £233,800 from their unappropriated profits. This action raises the firm's capital reserves to £1,212,500. The recommended dividend on the ordinary shares is an unchanged 15 per cent.

In his statement to his shareholders, Mr. King says that the year's highly satisfactory result was due largely to the continued efficiency of the firm's modern shipyard at Southwick. They delivered six new ships during the year, including two of over 18,000 tons deadweight. These vessels were Austin and Pickersgill's largest ships to date.

Their ship repair department also made an important contribution to the profits; the reconstituted graving dock at the Wear Dockyard being in operation during most of the year. In addition, the company carried out special surveys and repairs afloat to several vessels having a deadweight of 10,000 tons and above; thereby going well beyond the old range of the dockyard, which covered only much smaller ships.

And a Warning on Things to Come

This year's figures, that is, for the twelve months ended 30 June last, include profits on ships which were contracted for up to four years ago, before the present recession got into its stride: at a time when it was still possible to obtain orders with reasonable profit margins.

Austin and Pickersgill have now worked through these old orders and they report that their present contracts have been obtained at very keen prices. Therefore, Mr. King feels that he must warn his shareholders that the company's results for the year to 30 June, 1962, will inevitably show a markedly large reduction in profits, in comparison with the twelve months to June, 1961.

The firm's order book is satisfactory inasmuch as it will keep both their Southwick Yard and the building berths at their Wear Dockyard occupied for the ensuing twelve months. Another encouragement for all concerned is the activity of the company's management in their watch for new orders.

Austin and Pickersgill possess a modern well-equipped and efficient shipyard and Mr. King claims that they are constructing ships as quickly and cheaply as any other firm in Europe, if not in the whole world. They are in a position to offer prompt and speedy deliveries. Their biggest difficulty at the present time is the lack of adequate long-term credit facilities, available readily and at interest rates comparable with those obtainable abroad.

Many foreign owners insist upon substantial credit over long periods and, in addition, some British owners have placed orders abroad because of the attractions of the extended credit terms available there. In this connection, therefore, Mr. King considers that the lack of suitable long-term credit facilities presents the most important obstacle to British shipbuilding at the present time.

During the period under review, there were no labour troubles of any description in the organization. The team spirit throughout is " both notable and admirable."

Reduced Output of Passenger Vehicles

RANSOME AND MARLES BEARING COMPANY LIMITED, Newark, Nottinghamshire, have stood up well to a difficult year.

Last year, their chairman, Mr. Edward Senior, C.M.G., referred to the effects which the credit squeeze on consumer durables was likely to have on industry, and particularly on the motor trade. In his statement relating to the group's accounts for the twelve months ended 30 June last, he recalls that a definite recession did, in fact, develop and that it was not until the last two months of their financial year that any appreciable improvement took place.

Actually, the output of passenger vehicles in the year under review was no less than 25 per cent below that for the previous twelve months. Naturally, the firm did not escape the effects of this reduction in demand but they took the opportunity, thus presented, of building up their stocks.

Notwithstanding these difficult trading conditions, the net trading profit of the holding company, after taxation, for the year to 30 June, 1961, amounted to £727,000, compared with some £838,000 in the previous year. A second interim dividend has been paid, making the total distribution the same as for last year. The Group's balance remaining after the payment of dividends, around £510,000, has been carried to their revenue surplus, thereby bringing the total of this reserve fund up to nearly £3,266,000

Export Efforts Rewarded

Good progress, Mr. Senior reports, has been made in the construction of the Annfield Plain factory extension and this extension is expected to commence production in the near future.

The firm's efforts in export markets were made in the face of keen competition and were rewarded by an increase of some 30 per cent in turnover. At the same time, the results of two of the organization's subsidiaries in Australia and Canada respectively, were adversely affected owing to the difficult economic conditions ruling in those countries.

The group's associated manufacturing company in Australia—UNITED BEARING CORPORATION PROPRIETARY LIMITED—have been developing their manufacturing facilities rather more slowly than had been hoped, as a result of the recession in Australia. In this connection, Mr. Senior comments that it is pleasing to see that the Australian economic situation seems to be improving.

During the year under review, the parent company have considerably increased their facilities for the training of craft apprentices, in line with the recommendations of the Carr Committee's report entitled *Training for Skill*. These latest endeavours supplement the arrangements made by the company some years ago for the training of technologists. In this way, it is the group's aim to maintain a well-balanced intake of trained personnel.

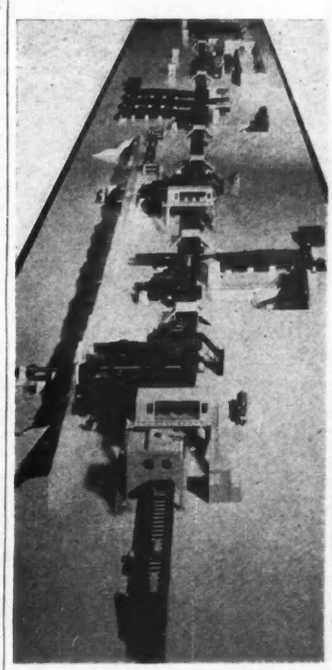
Mr. Senior emphasizes that his firm, who produce ball and roller bearings and lineshafting equipment, are dependent upon the requirements of all sections of the engineering group of industries. Demand from the capital goods industries remains at a high level, but he feels that it is doubtful whether the full effect of the recent action by the Chancellor of the Exchequer has yet been felt on consumer durables and, therefore, whether the trend during the current twelve months will be similar to that of the preceding period.

He is hopeful that the diversity of the group's interests will enable them to maintain a level of output adequate to produce a satisfactory year's training.

A Five Ton Model Travels By Air

Contracts for the Durgapur Steelworks, India, which were awarded in 1956 and have a value of around £120 million, are still on record as the largest single export order ever received by this country.

The DAVY AND UNITED ENGINEERING COMPANY LIMITED, Sheffield, as the main contractors, have undertaken the responsibility for four of the principal areas of the works, comprising more than one-quarter of the whole scheme. In order to assist HINDUSTAN STEEL LIMITED in their endeavours to acquaint the Indian public with the extent of the development in progress at Durgapur, Davy and United undertook to produce some extensive models of the plant, in order that these models might be put on display at the Indian Industries Fair now being held in New Delhi.



This 5 ton fully working model of part of the rolling mill plant at the new Durgapur Steelworks has been flown to New Delhi for the Indian Industries Fair. It is probably the largest model ever to travel in this way.

One of these is a fully-working model of a section of the rolling-mill plant, comprising primary and intermediate blooming mills and continuous billet mills, with their relevant ancillary equipment. The model, a view of which is to be seen in the illustration on this page, has been constructed to a scale of ¼ in to equal 1 ft by Clarkson and Son, York. Its overall measurements are 2 ft 8 in by 5 ft 1 in, with a height of 6 ft 3 in to the top of its canopy. A feature of the model is that it is electrically driven. All its various sections are explained by caption boards which carry descriptions in English and Hindi.

Nearly six months were spent in making the model and its cost amounted to several thousand pounds. It was flown to New Delhi in an Air India line freighter from London Airport and is considered to be the largest model to have been transported overseas by air.

When the fair ends on 31 December next, Davy and United will present the model to the Hindustan Steel Company for demonstration, training and forward-planning purposes.

More Decentralization by Birmingham Small Arms

A further stage has been reached in the policy of the BIRMINGHAM SMALL ARMS group for strengthening the organization's local managements and providing their operating companies with greater responsibility for their own affairs.

The group have now formed another two divisions: one covering general engineering and the other covering metal components. Each division will have its own board of directors and will be responsible for the affairs of four companies. In all, the BSA group of companies will comprise five divisions: the other three being concerned with motor cycles, machine tools, and steel, respectively.

Mr. A. J. Burton, who joined the group's headquarters staff in 1960 as director of manufacturing services, has been appointed managing director of the general engineering division, which comprises the following firms: BSA Guns Limited, Carbodies Limited, Monochrome Limited, and a new company, BSA (Redditch) Limited.

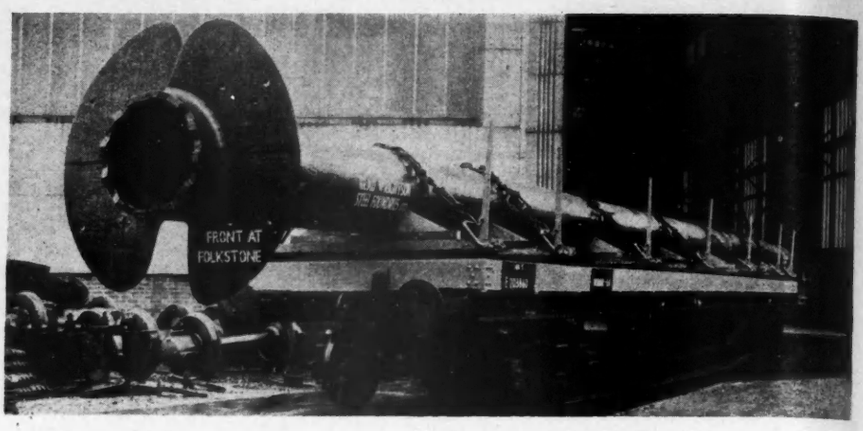
The last-mentioned firm will carry on certain motor-cycle and stationary engine work already being performed at Redditch, but they will eventually produce manufactures of their own.

The four companies in the metal components division are all concerned with time-saving cost-reducing methods of production. All are growth companies, operating in expanding markets and subject to rapid technological advances.

BSA Metal Powders Limited, one of the companies in this division, is located at Sparkbrook, Birmingham, and is one of the group's youngest firms. It possesses an important home market for pre-alloyed powders.

Steel Castings—Some Recent Examples

It should become clear from the brief commentary made here that it is well worth liaising with a steel foundry before deciding the final design of a potential steel casting.



THE STEEL castings shown on this page are taken from those being exhibited by the British Steel Founders' Association (BSFA) at the Engineering Materials and Design Exhibition, now being held at Earls Court (from 13 to 18 November).

Many of the statements made in the accompanying text may seem biased. They are in each case those of the steel companies, and are reported to have been carefully compiled in collaboration with the BSFA and the customers. Particular attention is drawn by BSFA to the thin-walled gear case (shown as the last example on this page) for use on a diesel locomotive engine. This now meets exactly the design criteria, they comment, and carries no excess weight.

Combined Gear and Clutch

The combined gear and clutch for earthmoving equipment shown on the right is an outstanding example of improvements brought about by close collaboration between user and foundry, say BSFA.

Originally the component comprised two forged clutches, a shaft and a cast steel bevel gear. These were partially machined, fabricated and then finish machined. The specification was then altered, cast steel clutches replacing the forgings.

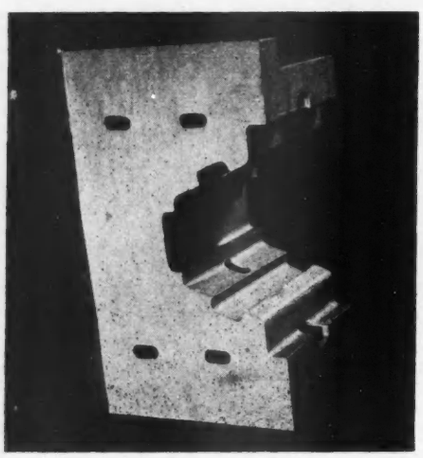
Finally, the component was re-designed as a one piece casting, giving a better job at a lower price. At the customer's request, similar components are now being re-designed in a similar manner. F. H. Lloyd and Company undertook the steel casting.

Cast-in Holes Eliminate Drilling

The application of up-to-date techniques by a modern steel foundry can now result in successful castings which a few years ago might have been a doubtful proposition, comment BSFA.

The top chock casting, shown below, for the segmental bearings on a 6 in rotary forge is a good example of what can now be done. The holes in the casting are 14 in long and only 1½ in thick in cross-section. They were formerly produced by a long and expensive machining operation but are now cored by an air-set technique with a base sand mixture of zircon and zircon flour. They are cast by Stewarts and Lloyds.

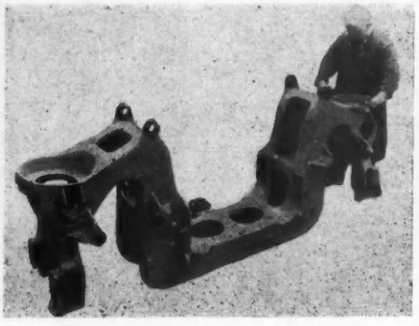
In this process the quality of the strip in the cored holes is such that no fettling, other than shot blasting, is necessary, and the holes are clean and straight.



Spanish Rail Bogies

The intricate bogie frames illustrated below are made as steel castings to give the strongest frame at the lowest weight, according to BSFA. Similar frames have been fabricated but, because of limitations in this process, have been replaced in railway service by steel castings. The superiority of steel castings has been established in service as well as by tests conducted under laboratory conditions.

Whilst sufficiently intricate to be admired as a one-off example of the steel founder's art, these castings are being made on a series production basis and that shown is one of 200 to be made for the Talgo trains in Spain. They are cast by English Steel Castings Corporation for Patentes Talgo S.A. of Madrid.



84 ft Cast and Welded Tubes

BSFA note that an outstanding example of successful collaboration between the user and a modern steel foundry is given by the pile tube for the Dungeness power station water intake cooler pile, shown above. Specifications for this were as follows:—

Length of each pile, 84 ft
Diameter, 30 in. $\pm \frac{1}{8}$in
Tolerance for straightness on overall length, $\frac{1}{2}$ in maximum; and on thickness not more than $-\frac{1}{8}$ in
A ring gauge 9 in long to be passed over entire tube length

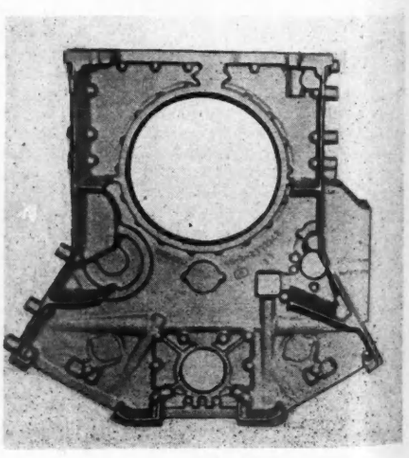
Each pile to be subjected to a strain test by applying various loads by means of 100 ton jacks. Steel foundry technicians decided that the tubes should be cast in eight separate 10 ft lengths plus the helix, and joined by welding. The CO_2 process was used for coremaking and moulding to give the finish and close tolerances required. Weld preparation at each end of the tubes was carried out by machining, and magnetic particle crack detection was applied to all welds.

Delivery of these successful steel castings by Head Wrightson Steel Foundries to Sir Robert McAlpine and Sons began to time in five months from the first consultations.

Thin-Walled Gear Casing

Another casting which would not have been possible a few years ago, according to BSFA, is this gear case for a diesel locomotive engine. Cast in BS592 grade A steel, it has sections of 0·20 in tapering to 0·10 in, and is manufactured on a quantity production basis.

Measuring 37 in by 35 in by 6½ in, it weighs only 194 lb. Casting was undertaken by K and L Steelfounders and Engineers.



Improved High Speed Steel

A high speed steel made by Firth Brown under the name Speedicut Vanleda contains 5 per cent of vanadium and cobalt and is described as being of improved quality. A high proportion of the vanadium is present as vanadium carbide which is said to confer high abrasion resistance with little or no loss of toughness.

Firth Brown comment that many of the problems in machining under present day conditions have been solved by the use of sintered carbide, but there are still occasions when carbide tips are unsuitable because of lack of rigidity or because the design of the tool is unfavourable. Good results have been obtained with Vanleda when machining difficult materials such as heat resisting steels and alloys, but worthwhile improvements have also been obtained with low alloy steels and chilled iron.

Speedicut Vanleda can be used for turning, milling, drilling, boring or shaping, and compared with 18 tungsten or cobalt high speed steel, the makers say it has been found to give longer tool life with increased output between regrinds. High speeds, feeds, and good finish are said to be possible.

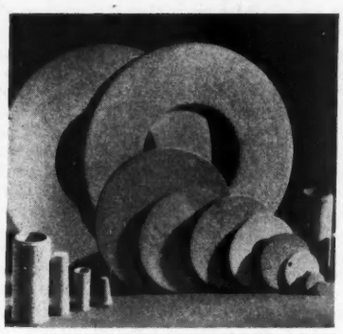
Thos. Firth and John Brown Limited, Atlas Works, Sheffield 4.

Porous Filters in Stainless Steel

Porous stainless steel for filters is now being offered by Bound Brook Bearings. The makers say that it is suitable as the base for fluidized beds and for the distribution of fine gas bubbles in liquids.

This filter material is available in sheets up to 600 by 300 mm in three standard thicknesses of 2, 3 and 5 mm. There are eight grades of filtration covering the range from 3 microns to 75 microns, the thickness being adjusted according to the grade. Thus the finer grades are available in the 2 mm thickness and the coarser grades in the 3 and 5 mm thicknesses, with some overlapping for the intermediate grades.

Bound Brook say that the material is suitable for use up to 600° C in air and in certain cases



up to 850° C. The coefficient of expansion is $17{\cdot}5 \times 10^{-6}$ per deg C over the range 20 to 500° C.

Where the corrosive conditions are not oxidizing and where stainless steel is otherwise unsuitable, such as in the presence of halogens, the same range of elements is also available in Monel.

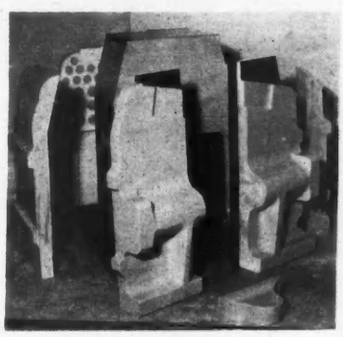
Initial production of the stainless steel and Monel porous materials is being centred on flat sheet, discs and washers, all of which are being manufactured in standard sizes. Hollow cylinders open at each end and capsules are produced by bending and welding flat sheets and are available in a standard range of sizes. Non-standard sizes and cylinders closed at one end and having a pipe connection at the other can also be produced for special requirements; elliptical elements with internal supports are specially constructed for each application. For small quantity orders, however, the makers suggest that filters should be chosen from the standard size range.

Bound Brook Bearings Limited, Trent Valley Trading Estate, Lichfield, Staffordshire.

Reinforced Plastic Foundry Patterns

Glass reinforced plastic with a variety of fillers has reduced the weight of certain patterns made by British Railways at their Southern Region locomotive works at Eastleigh.

The patterns made recently include one for the moulding of steam heated radiators used in carriage heating. This consisted of two parts each with eighty-five $\frac{3}{16}$ in thick parting webs between the fins, a tight dimensional tolerance applying to the overall length of this item. Every fin and intermediate body section is faced with impregnated mock leno Duraglas glass cloth, supplied by Turner Brothers Asbestos, and laminated with epoxy resin. Turners comment that the construction has resulted in a pattern of considerably less weight than the metal pattern it replaces. It can be easily



stripped by hand and can be moved about the foundry without the use of a crane.

A further example of attaining a reduction in pattern weight is the one used for moulding wagon axle boxes. Each section of this pattern has an epoxy glass facing, the main body of the pattern being filled with cork and vermiculite. Although the fitting and interlocking of all parts is quite involved, say Turners, there has been no evidence of any excessive wear. The sections of this pattern are shown in the illustration.

Turner Brothers Asbestos Company Limited, Rochdale, Lancashire.

Inflatable Raft in Coated Nylon

A sectional, collapsible raft capable of supporting a load of 10 tons has been developed by a Southend firm, Lea Bridge Industries.

The raft consists of 12 buoyancy units made from what British Nylon Spinners describe as an extremely strong and durable coated nylon material held together by a lightweight metal framework. The chosen fabric was an 8 oz nylon mock leno base cloth coated with neoprene to a total weight of about 30 oz per sq. yd.

The raft weighs only a little more than a ton and collapses into a bundle for transport. It is claimed that it can easily be carried slung beneath a helicopter and can be assembled and made ready for use quickly and easily. The unladen raft draws about 2 in of water. Bearing the 10 ton load it draws about 12 in.

Intended primarily for the transport of vehicles, the raft has been designed for propulsion by two outboard motors or by towing. Investigation is also being made into the possibilities of towing it by helicopter. British Nylon Spinners report that successful beaching trials have been carried out with two leading buoyancy units deflated.

Slight modification enables rafts to be joined end-to-end to form a pontoon bridge or roadway. Rafts can also be linked together with planking to make a landing stage for off-shore loading and unloading of vessels.

Now under trial in the Far East, the Lea Bridge 10 ton raft is said to be the newest of a wide

range of inflatable craft now being made from coated nylon fabrics. These include life rafts, yachting dinghies, assault craft and collapsible catamarans.

British Nylon Spinners Limited, 68 Knightsbridge, London SW1.

Nylon and Polyurethane Wheels

Plastic Engineers of Treforest are now supplying truck and trolley wheels made in nylon. They are claimed to be quiet running and not to need continuous lubrication while being suitable for heavy loads on uneven passages.

The makers say they can supply wheels up to 12 in diameter, the largest of which weigh several pounds. It appears that they have neither a

centre hub of different material nor a bearing because of the claim about lubrication.

A different firm, Flexello Castors and Wheels, are offering metal wheels with tyres made from polyurethane rubber. Like nylon, this material is expensive, but tough. For instance, it is claimed that the brand of polyurethane used by this firm, namely Superthane, will support four times the load of good quality rubber; has a working life at least ten times that of rubber; will not pick up chips, etc.; will not develop flats; and is not harmed by temperatures from −20° C to 120° C.

These polyurethane tyres are being applied to the company's range of 50 swivelling and stationary castors in diameters of 6, 8 and 10 in. One of them is illustrated.

Plastic Engineers Limited, Treforest, Glamorgan. Flexello Castors and Wheels Limited, Slough, Buckinghamshire.

Operational Research, Management's Need

Of all the management techniques which, necessarily, have mushroomed in the last two decades, Operational Research is the most truly scientific. It is also the technique about which management tends to be most chary.

OPERATIONAL Research differs essentially from most of the other management techniques in that it applies, not only scientific method, but science, to management. At different times, operational researchers have defined the technique as "the method of working a large, complex and probabilistic system of men, materials, machinery and money as an integrated whole," as "the provision of a quantitative basis for management decisions," and, most cosmically of all, as "the application of scientific method to everything and anything." Never, indeed, have such wide claims been made by such discerning men for one management aid.

The fact that operational research specialists rarely define their work or, when they do, talk of it in all-embracing terms, is an indication of the scope and depth of the technique. Indeed, to try to define it is usually either to speak so broadly that the definition means nothing or to localize it so much as to confuse the means with the end. Even the term, operational research, is misleading, and some practitioners prefer to abbreviate it to OR. Americans, as is their habit, worry more about producing a neat definition or formula for the technique, but even they are more reticent than usual on this point.

Perhaps it is more rewarding to talk about the nature and character than about the definition of operational research. Its nature is the identification and the measurement of the variables and apparent uncertainties in an industrial (or any other) activity or system, with the object of deducing the most effective balance of forces within that activity or system. In other words, the scientist treats the management problem before him as he would a problem in his own discipline. As an operational research man has said, "When people trained as mathematicians or scientists come face to face with the operating problems of a business, then operational research is what happens."

ORIGINS

Operational research is characterized essentially by the illustration of structural relationships with logical, mathematical or, sometimes, physical models. These models are virtually analogues of systems which make it possible to observe and study the full-scale systems without building them. In building such a model, an operational research team might draw upon an analogy from almost any branch of science. They would apply to this task such scientific tools as mathematics, statistics, symbolic logic and probability theory.

The technique is British in origin, and it is to the shame of British management and the British educational system that, under the name "operations research," operational research has been used much more widely in the USA than in this country. Like some other specialisms, such as ergonomics (ENGNG., 1 Sept., p. 280), it had its beginnings in the wartime bringing together of scientists of different disciplines for the severely practical purpose of handling the complex management problems involved in prosecuting a major war. These scientists were surprised to discover the close structural and causal affinities between their sciences and problems of organization and management.

Decisions on such subjects as the optimal balance between firepower and speed in fighter aircraft were arrived at on the evidence of operational research. It played a vital part, too, in making the best use of radar coverage, and convoy protection and submarine hunting were made several times more effective by its use.

After the war, the teams of scientists which begot operational research broke up and returned to industry and elsewhere. Since that time, the use of operational research has developed and extended rather more slowly, though a number of manufacturing firms and organizations have taken advantage of it, particularly in the steel industry. It seems that it has prospered in this industry largely through an accident of personalities—through the presence of people like Sir Charles Goodeve who had helped to originate the technique during the war. Perhaps, too, management in steel has been stimulated by being in the limelight of the nationalization and denationalization wrangles. There might even be a more intrinsic reason for the steel industry's progressiveness since, after all, it was there that F. W. Taylor first conceived the idea of scientific management.

The steel industry has been flying the operational research flag among the research associations, too, in that the British Iron and Steel Research Association have a very powerful team of scientists engaged on operational research and allied techniques and sciences. Some of the other DSIR sponsored research associations are also working along these lines.

MANAGEMENT CONSULTANTS

Another stimulus has been provided by management consultancy. Some of the consultant firms which are members of the Management Consultants Association—people like Associated Industrial Consultants, Personnel Administration, Production Engineering, and Urwick, Orr and Partners—have operational research divisions within their organizations and so are able to build up operational research applications against the background provided by their other consulting activities. In many cases, however, these divisions have introduced applications to client firms which have not previously used consultants for the less sophisticated techniques.

A very lively newcomer to the consultancy field—specializing in operational research—is SIGMA (Science in General Management Limited), which has as its managing director Mr. Stafford Beer. Until recently, Mr. Beer was Head of Operational Research and Cybernetics with United Steel, a post in which he directed and controlled a scientific staff of more than seventy and was responsible for pioneering new developments in the field of management sciences. Now, SIGMA is to create teams of different types of scientist and so be able to draw upon scientific knowledge of how large systems work and behave, "whether physical or chemical, biological or social, economic or electronic, anatomic or psychological." A tall order, indeed, but, then, so is operational research.

SIGMA's ancestry is interesting. It is the product of a partnership between Martech Consultants, of London, and SEMA (Societé d'Économie et de Mathematiqué Appliquées), of Paris. This latter body has provided extensive help to the Commissariat au Plan in drawing up its now famous four-year national economic plans (ENGNG., 13 Oct., p. 470). The French, in fact, have done some very advanced work in operational research.

Another medium through which the coming of operational research is propagated is the Operational Research Society of Great Britain, a body which was founded, as the Operational Research Club, shortly after the war. This organization is in the nature of a learned society, with its own quarterly magazine, and now having nearly 700 members, nearly 400 of whom have practical experience of operational research projects of various magnitudes. The papers given and discussed at meetings of this society have, over the years, played an important part in the development of operational research techniques.

VIS-À-VIS OTHER TECHNIQUES

To some extent, operational research is interdependent with the other management techniques, at least in industrial applications. Indeed, it seems reasonable to say that operational research is unlikely to be of great value—or, anyway, of easy application—where management has not already appreciated the usefulness of the less sophisticated management techniques. For example, most applications depend to some extent on the availability of sound costs, so that an effective system of cost accounting is normally desirable, even if the particular data required for operational research have to be an extrapolation from the normal method of presenting costs.

Work study is another technique with, at some points, a close affinity to operational research. Some people do not even recognize the borderline between the two techniques, and some firms find it advantageous to link them for administrative purposes though, where this happens, there are mixed views about whether the operational research department should contain the work study function, or the work study department the operational research function. In practice, decision on this point seems to have rested on the principle of first come, first served, but, because by its very nature operational research must have the ear of top management, the logical way round appears to be to make it the senior partner.

By and large, the best way to put both cost accounting and work study in perspective with operational research, is to regard the former two as tools of the latter—as the measuring instruments upon whose readings the latter must to some extent depend.

Another technique which is very closely identified with (but is no less sophisticated than) operational research is cybernetics. This latter technique, "the science of communication and control in the animal and the machine," is one of which Mr. Stafford Beer is probably the leading advocate. The rather ugly name, "cybernetics," is derived from the Greek word for a steersman, a name which is appropriate for, taking the analogy of the human body's built-in system of communications and automatic reactions, cybernetics is concerned with establishing such a self-compensating nervous system for industrial and other organizations. An example of the human body's cybernetic prowess is the "good eye"—the ability to respond correctly and immediately to an unexpected situation—of the cricketer or other games player; cybernetics sets out to give this quality of "good eye" to industrial organization and management.

Again, the exact relationship of operational research to cybernetics is not fully agreed. One school of thought—apparently the biggest—sees cybernetics as being contained within operational research, while another sees cybernetics as the inclusive technique. Yet another school of thought is, so far, a little cynical about the practical application of cybernetics at this stage in its evolution. All three schools, however, are agreed that operational research is here to stay.

There are many occasions when the data needed in an operational research study are so complex and require such involved calculation that they must be processed on computers. Since the problem of communication between men can become quite acute in the abstruse

In producing this article, acknowledgement should be made of the kind help and guidance received from Mr. Stafford Beer (of SIGMA), Mr. John Harling (of Urwick, Orr and Partners), Mr. Brian P. Smith (of Personnel Administration), and Mr. C. S. Chedzey and Mr. R. J. Taylor (of Associated Industrial Consultants) though, of course, these gentlemen must be absolved from all responsibility for the end-product.

field into which operational research sometimes leads, many people think it advisable for the operational researcher to be able to carry out his own computer programming. In view of the variety of computers in use, however, it is clearly impossible for any one operational research worker to be able to handle all the programming he will ever meet.

Nevertheless, it is useful if the various members of any one operational research team can develop an expertize in handling different kinds of computer, so that most computers commonly in use can be handled, if necessary, by one or other member of the team. Again, it is often possible to make the distinction—more commonly made in the USA than in this country—between programming and coding. In this way, the operational researcher can sometimes process his own work (using logical flow diagrams) so far that it can then be treated by the computer coder with a comparatively minor communications problem between the two men.

THE SCOPE

The scope of operational research is immense. There are several cases where it has been employed by civil governments at national level. All branches of the USA government are understood to use it, and they now have an operational research scientist as Assistant Secretary of Defence. Like the French, the Indian Government have used it in producing their national economic plans; in Norway, it has been used in creating a strategy for minimizing the national debt; and in Egypt it has been employed for apportioning priorities to national planning targets. Perhaps our own projected National Economic Development Council will find operational research as useful an economic planning aid as have the planners of these other countries. The technique could also be used to advantage and profit by many of our existing government departments.

Within industry, the ideal is that operational research should be used to cover absolutely every aspect of a firm's activity—to consider the demands and requirements of every section and department in order to arrive at an optimization of the company's total resources. Such a global type of application is the ultimate in operational research and is referred to by some people as the " strategic approach."

The classic case for this overall strategic approach—for an evaluation of the competing demands of different company activities—is the situation where (*a*) the sales department, in bending over backwards to keep customers sweet, press for short runs, unscheduled orders, short-cut deliveries, and a variety of products; (*b*) the production management, in seeking high plant utilization and ease of production scheduling, stick out for long production runs, standard sizes and, if necessary, long deliveries; while (*c*) the firm's financial interests are seeking to keep down stocks and inhibit both the sales and production departments' aims. In a situation of this kind, only a technique as big and as scientific as operational research can resolve the order of priorities which is truly to the company's advantage.

However, while the technique is admirably suited to so-called strategic problems such as this, it can also be used most effectively for specific and sectional investigations within a company. A wide variety of specific or " tactical " problems can be handled in this way, and they include control of stocks and production scheduling; programming and allocation problems; waiting line and congestion problems; tender bidding; determination of price structures; the allocation of effort within sales territories; the division of production within multi-unit firms; the organization of large transport fleets; economic process mixing; and (very useful indeed) the evaluating of research programmes.

A technique as scientific and as sophisticated as operational research is clearly not an economic proposition for too small a firm. The general assessment seems to be that a firm with a turnover of £20 million per annum is likely to have enough operational research work to set up a team of scientists of its own. Below that turnover, but above a £3 million turnover, a firm is unlikely to have enough operational research work to sustain a team of its own but it is very likely to have enough problems to make liberal use of consultant operational researchers for *ad hoc* purposes. Below a £3 million turnover there is some division of opinion about the economics of using the technique, though some apparently very successful applications have been made in firms with rather less than £1 million turnover.

THE APPLICATION

Operational research originated as a science applied by a team, rather than by an individual, and, though such an animal as the compleat operational researcher seems now to have emerged, it remains very much a team technique. This is partly because the experience of a variety of sciences is usually necessary to establish the correct scientific analogy to a problem, and partly because operational researchers have a cross-fertilizing and stimulating effect on each other's ideas. Teams vary in size tremendously—United Steel's team of over seventy has already been mentioned—but the smaller teams have sometimes had a rather more perilous existence. Where, on one or two occasions, an operational research team has gone to the wall, it has usually been a small team of three or four scientists which has not been given sufficient resources to implement its work properly and has had little more than token support from top management.

Some of the mathematical content of operational research work is obviously of a high order but it is fallacy to think that every operational research man should be a first rate mathematician. Indeed, if he were he would probably become too inflexible in his thinking to be a useful member of the team, in the same way as would a scientist who became too embedded in his particular discipline.

In making an operational research application, it can normally be taken that there are the following eight principal stages:—

(1) Defining the task.
(2) Limiting the scope of the task.
(3) Assembling relevant data.
(4) Constructing a theoretical model (the essential characteristic of operational research).
(5) Testing hypotheses on the model.
(6) Processing the relevant data according to the hypothesis selected on the model.
(7) Communicating the result.
(8) Ensuring that the application is fully and correctly maintained.

In addition to his problems of technique, the operational researcher, in common with specialists in other techniques, has his human problems in putting his ideas across and in making them acceptable. This human relations angle may not take up quite such a high proportion of his efforts as it does with, for example, the work study engineer (if only because the operational researcher does not have the sheer quantity of people to deal with on the shop floor, though, of course, some board rooms can be more intransigent than any shop floor), but it is still a very significant part of his job.

The operational researcher's human problem begins right at the top. His work is so basic and so fundamental to company policy that he must have the direct confidence and the direct cooperation of the board of directors, if his ideas are to be properly considered and, when accepted, implemented. However, not only must his work be explained upwards to the board, but downwards, as far as junior management to the people who will have to put the application into routine use and, by misuse, could invalidate the whole exercise.

This latter point is important for, as with the less sophisticated and less science-based management techniques, the successful implementation and maintenance of an application depends very much upon the people who have to run it. It is therefore a frequent practice—again, as with the other management techniques—for an operational research team engaged on a particular project to ensure that proper advantage will be taken of its work by training someone to use correctly the system which is evolved. The people chosen to run such a system do not have to be high-powered scientifically, in the same way as the operational researchers who create the system, but they do have to be very good executive material and selecting them should always be treated as a major and serious exercise.

In this country, there are nearly one thousand operational research scientists of one kind or another, each of them playing a useful part in the work of his particular team. Of these one thousand people, however, there are probably fewer than two dozen who would be capable of leading and integrating a major project. This is in direct contrast with the USA where the close contact between universities and industry has resulted in a steady output of highly trained operational research specialists. In Britain there are only two or three universities which attempt to train such people.

MISSED OPPORTUNITIES

It is not every scientist who can be trained successfully in operational research work, because it is necessary for him to be able to understand management problems (and win the confidence of management) and then translate them into the language of science. He has to be part of the worlds of both science and management, and much of our scientific education is not of a kind that is likely to produce this flexibility of mind and interest.

However, though the compleat operational researcher is a rare being, he is still numerous enough to direct more projects than management has so far been prepared to let him handle. British management, in fact, is failing to take advantage of the most effective technique at its disposal—an attitude of mind which we cannot afford in our present economic position and which, in the colourful phrase of a leading operational researcher, " is symptomatic of a thoroughly alarming decline in the rate of our national metabolism."

Very often, management's reluctance to bring in operational research scientists springs from a basic misconception about the nature of modern scientific education. They tend to take a Victorian view of the science disciplines and do not understand their relevance (in spite of the limitations in some science teaching, mentioned above) to the quantitative analysis of organizational variables.

Sometimes, too, management tends to go in awe of the high order of mathematics involved in operational research studies. This, again, is an unreasonable attitude. Many of the models used in operational research are based on logic, not mathematics, and one firm of consultants has sometimes reported back to management without once quoting a mathematical formula. Even where the mathematics is rather abstruse, this is still not a management problem, for the model constructed by the operational research team will give management an opportunity of understanding the possibilities of the full-scale model. These models, incidentally, are similar to the business games used on the Oxford and Cambridge summer schools and other management courses. Perhaps these courses will therefore further diminish the management antipathy for operational research, but they can have significant effect only in the very long run.

Yet another misconception about operational research is the belief of some managers that it must take the humanity and the art out of management. In fact, it recognizes the human element as one of the variables of management, and, instead of obscuring it behind a cloud of conjecture, acknowledges its importance. Indeed, operational research can be used in assessing the variables involved in such essentially human applications as incentive schemes and the probable incidence of sickness. It is not the humanity that is taken out of management by operational research, but the guesswork, the caprice and the whimsy.

On the Shelf

By Frank H. Smith

My wife anticipated the current leather manufacturers' attempts at converting the despatch case into a status symbol (" Success shows naturally in a LEATHER briefcase—perhaps it's time you had a new one ") by about three months: I am now saddled (an appropriate verb in view of the stack of leather in it) with one of those triangle-section efforts that look like a young weekend case. Mind you, it is ideal for a couple of quart bottles, a Stilton and a French loaf but it weighs half a ton empty. It makes one take home too much work and it's just the wrong height. Three times a week it catches and unhitches my sock suspender, and a trailing sock suspender counteracts all the dignity of an initialled (F.H.S., of course) leather briefcase. Also it catches in the front wheel of my bicycle.

A strange leaflet from Academic Press. They announce the publication of *ASLE Transactions* beginning with Volume 4, No. 1. There's no indication of where you get the other three, but since ASLE is initialese for American Society of Lubrication Engineers one assumes they have the first volumes. One also assumes that ASLE is pronounced as one does ASME. (Too much assumption in this paragraph.)

I don't know how you feel about the German Democratic Republic, but in case you do they offer you an " over-all picture of life in the G.D.R." in a *Pocket Guide* on which they invite your comments. Write to Society for Cultural Relations with Foreign Countries, Berlin W8, Thälmannplatz 8/9, but don't say I sent you.

A catalogue devoted to Mathematik und Naturwissenschaften books is available from B. G. Teubner, Verlagsgesellschaft, Stuttgart. They go in for this sort of thing in a big way, but if you cannot read German it's not a lot of good. There are few, if any, pictures in that sort of book.

Its author wins a mention of North-Holland's (68-70 NZ Voorburgwal, Amsterdam) *Quantum Mechanics*, by A. Messiah. Volume I at 100*s* is out, and Volume II will follow. Both are translated from the French (into English for a Dutch firm—what more could you want?)

There is usually some difference between the journal and the transactions of any given society, but you will have to go a long way to find a more pronounced difference than there is between those of the Japan Society for Aeronautical and Space Sciences. The journal is in Japanese and the transactions in English.

Not so very long ago the science of indexing had a pretty good airing in *The Times*. The Society of Indexers (3 Western Mansions, Western Parade, Barnet) deserve more support. I have been to only one of their meetings and am not, therefore, qualified to preach but I feel that their meetings should be better attended so that discussion could bring out more views on what, in indexing, is required. It does sound a pretty tedious subject, I know, but if you have ever used the telephone directory (and who has not?), have you ever realized how simple it is in use or thought that there might be somebody who has to work it all out? On 9 November the Society had a lecture on " The Compilation of the Telephone Directories with special reference to their Alphabetical Arrangement." On 12 December, Mr. Richard Bancroft, superintendent of the B.M. Reading Room, will speak on "The British Museum Subject Index " and on 22 January 1962, Mr. Christopher Kent will talk about "The *Encyclopaedia Britannica* Index: How it is Compiled." Either or both of these should be a lesson to those who do not know where to put Macs and Mcs in relation to Machinery and McIntosh and whether initials like T.U.C. should come at the beginning of the Ts' or before Tuck. Mr. G. Norman Knight is the Hon. Sec. at the address quoted.

Pilots and Planes

Testing Time. By CONSTANCE BABINGTON SMITH. *Cassell.* (30*s*)

Although many books have been written by, and about, test pilots and their experiences, there has been no published history of the development of aircraft test flying. *Testing Time* is an attempt to fill this gap—" there has been urgent need for a book that views the subject in longer perspective," the author states in the preface, " and traces its development from the earliest beginnings until the present day."

But perspective viewed from too remote a standpoint is liable to be flat and lacking in impact; and that is the case here. Miss Babington Smith, one-time member of *The Aeroplane* editorial staff under C. G. Grey, is well known as the author of a highly interesting book, *Evidence in Camera*, describing the work of the photo-reconnaissance units during the Second World War. In that earlier work she spoke with the graphic authority of one directly concerned with what she was describing. In *Testing Time*, although clearly she has devoted much research to the subject and has unearthed hitherto unpublished data of considerable interest, she speaks as an outsider looking on; and in aircraft development, it is rarely that the onlooker sees most of the game.

The subtitle, " A Study of Man and Machine in the Test Flying Era," gives some idea of the way in which the author has approached her subject—by consideration of selected individual test pilots and their influence upon the art of test flying and the design of aircraft. She has restricted herself to the British scene, and deals with the period from 1908—the days of J. W. Dunne, Samuel Cody, Geoffrey de Havilland, A. V. Roe—up to the present day. From Miss Babington Smith's viewpoint, the pre-1918 era looms very large indeed, occupying the whole of the first half of the book—" that was the time when test flying came into being, and in the early setting the basic issues can be seen at their most vivid."

In the latter half of the book, she concentrates almost exclusively on high speed flying—problems of the Schneider trophy racers, development of the Spitfire fighter, the advent of jet propulsion, the conquest of the sound barrier. Admittedly the flight development scene after the Second World War has been dominated by compressibility and associated control problems, but the implication that only the high speed aircraft engenders problems for designer and pilot is simply not justified.

The early days of official acceptance tests and research flying provide two of the most interesting chapters. During the First World War, there was growing awareness of the need for scientific method and precise measurement in test flying, and the Testing Squadron was formed under the guidance of scientist-pilot Henry Tizard, firstly at Upavon and later at Martlesham Heath. " Soon, under Tizard's lead, the very name 'Martlesham ' came to stand for everything that was most accurate and thorough in test flying." Meanwhile Squadron Leader Roderic Hill of the Experimental Flight at the Royal Aircraft Establishment, Farnborough, " brought test flying to science " just as Tizard was bringing science to test flying. It is a pity that the author does not follow through the further evolution of testing requirements and techniques, and the relationship between firms' test flying, official research flying and aircraft acceptance tests, and the way the emphasis has changed with the passage of time—but the telling of that story requires a narrator with inside knowledge.

M. NEAL

Car Design Review

The Private Car: Crompton Lanchester Lectures of the Automobile Division of the Institution of Mechanical Engineers. *Institution of Mechanical Engineers.* (30*s*)

In contrast to their normal proceedings, the Automobile Division of the Institution of Mechanical Engineers has grouped together in one volume a carefully planned series of twelve lectures covering the major aspects of modern car design. In order that these lectures should cover a broad field and be informative to all who have an interest in cars, it was not intended to introduce too much technical detail, nor to indulge in overspecialized treatment of each subject.

With these terms of reference the twelve individual experts chosen to deal with their own subjects have produced very readable and informative matter. It is a logical step that the collection should be published in a single volume, although it is, perhaps, unfortunate that the title *The Private Car* suggests that the contents are only applicable to those who are obliged to provide their own unsubsidized transport.

In such a context it is incumbent on the contributors to avoid being over-ambitious, and it is a little surprising to find the volume starting off with a somewhat rhapsodic foreword which, apart from pointing out the need for understanding of the final commercial objective on the part of the designer, seems to suggest that the designer should not be confused, too much, by facts and figures.

If car design in Britain has relied for its enterprise upon artists rather than engineers, this is surely because of lack of science, rather than its surfeit. No doubt conservatism of outlook still exists in this country, but if this merely means that we like to know how a thing works before we commit ourselves to spending a million or two on manufacturing plant, this is by no means incompatible with evolution or even revolution. It is true that over-simplified theoretical approaches to many problems of car design have led to false conclusions, but the remedy lies in improved and more clearly understood theoretical and experimental techniques, rather than in intuition. The analogue computer cannot yet design a complete suspension system for a car, but it can certainly save a great deal of expensive experimentation. In production processes it is well accepted that we must use every tool we can afford to speed up the process, to produce great consistency and to avoid waste of manpower and material. Similarly we must use all the aids available to improve our designs and make them equally efficient.

Although the twelve subjects chosen to form this collection have been well selected to include all major aspects of vehicle design and development, the standard of the individual contributions is variable.

It would be expected that with their terms of reference the contributors would have avoided going too fully into specific details of design, but would have concentrated on a broad view of the current design situation, a review of the basic requirements for such design and some insight into future trends. Certainly, no impression can be formed of any major developments which might take place in the car of the future, and comment in this respect is generally limited to developments of a minor nature which appear to be justifiable beyond the point of debate. The contributors have wisely not over-indulged in past history, but have introduced this aspect only in so far as it has a very radical bearing on the current situation.

The whole volume appears to follow the theme of established design, and this is particularly so in the case of those sections dealing with power units, where efforts have been made to justify

current practice at the expense of schemes and systems which the average engineer would readily dismiss in any case. It is true that this book is intended for a wide selection of readers, and many with limited technical knowledge may be comforted to know that the motor industry is working on such proper lines.

Nevertheless, there is a good deal for even the well informed engineer to absorb. The excellent description of the precise nature and magnitude of the problems facing the electrical engineer in producing a complete system for cars is one outstanding example.

Some of the topics dealt with are in themselves of great practical interest to the day-to-day motorist, and it is most useful to have some very common misconceptions cleared up. The excellent explanation of lubrication problems, in particular, is genuinely informative in a field which is the subject of so much commercial assault upon the gullible motorist.

It is perhaps unfortunate that the question of safety in accidents, which is one of considerable current interest and concern, is dealt with so inadequately and in an almost nonchalant manner. It is difficult to believe that the motor industry is so undemocratic as to believe " might is right " in the case of a head-on collision.

The reader is left to guess at the future, rather by omission than by comment, although it is easily inferred that in certain fields, e.g. automatic transmissions, there are still many runners in the race and no clearly established favourite, despite an obvious need for new development. As there is no reference to either gas turbines or to other forms of rotary engine, it is not clear whether these are considered to have a potential future or not, as such omissions could suggest either that they are too insignificant to bear consideration, or that they are too imminent commercially to permit the risk of comment at this juncture.

Despite one or two recent examples of new design thinking in British motor cars, there is a general feeling that a very standard pattern is being approached asymptotically. This view is certainly not held by forward thinkers on the problems of personal transportation. Authorities of the calibre commissioned to contribute to this series of lectures should certainly be expected to rank among these forward thinkers, and the conservatism which permeates the whole volume is doubly unfortunate in depriving the reader of exciting possibility and in conveying a general impression of self-satisfaction with the present state of design. Happily, the true situation is somewhat less complacent, as there are still a few uninhibited engineers with sufficient support from their management who are, at the present time, pushing ahead with new developments which could radically advance the functional ability of the private car.

Notwithstanding these criticisms, this volume is a valuable addition to the library, and, by one means or another, will provoke the enquiring mind into further thought and discussion.

D. J. K. STUART

To Perfect Reproduction

High Fidelity Sound Engineering. By NORMAN H. CROWHURST. *George Newnes.* (50*s*)

Norman H. Crowhurst, A.M.I.E.E., the author of *High Fidelity Sound Engineering*, has been active in the sound engineering field since 1935, and during that time he has been Senior Lecturer at the South-East London and the Beckenham Technical Colleges. In 1953, he went to America where he now practises as an engineering consultant and writer. Mr. Crowhurst is also a senior member of the I.R.E., a member of B.S.R.A., and Acoustical Society of America; Fellow of the Audio Engineering Society and Associate Member of S.M.P.T.E. This book, therefore, is the writings of an extremely knowledgeable engineer.

The reviewer found the book most stimulating reading right from the beginning. Because it is written in very easily read language, one does not have to get used to the author's style, therefore the information which the book contains can be absorbed immediately; in this respect it is an unusual sort of text-book.

The author has set out to put before his readers all the main requirements for satisfactory reproduced sound. It is pointed out that " perfect" reproduction at home is not, as yet, a practical proposition. This latter statement is backed up by detailed descriptions of the human hearing faculties, including loudness curves by Robinson and Dadson (probably more commonly known as Fletcher Munson curves). Chapters concerned with basic circuit elements follow, including simple active circuits, transformers and L.C. filters, leading on to power amplification and feed-back. Transient performance is dealt with particularly well; in this section reasons are given why some amplifiers perform better without feed-back, showing to the engineer and student alike some of the more hidden detail in amplifier design. In this respect the book excels.

In a book of this size, it is perhaps surprising to find that forty-seven pages are devoted to transducers and transducer matching—a much more important aspect of sound engineering than is generally realized. Usually the main consideration here is given to loudspeakers but Crowhurst has outlined microphones, pick-ups and tape heads as well as loudspeakers, thus imparting to the student a much better understanding of what is required in a complete system. This is followed by chapters dealing briefly with oscillators, sound generators, test equipment and the control of acoustics.

From what has already been said of *High Fidelity Sound Engineering* one might be inclined to think that it forms the answer to the audio engineers' prayer; unfortunately, this is not quite true. Obviously, a good deal of information has been omitted, but this must be so—otherwise it would not be possible to lift the volume out of one's bookshelves. However, the book is not likely to date quickly as valves and transistors receive equal consideration. But, as there are now recognized standards regarding recording/replay characteristics for tape and gramophone equipment, the inclusion of perhaps the R.I.A.A., N.A.R.T.B., and C.C.I.R., curves would have been of value both as a reference for the engineer and a guide to the student.

The author obviously understands the needs of engineers engaged in this type of work. So often when one refers to text-books it takes a lot longer to find the information than need be, because the text is continually being illustrated by mathematical analogies—these are, of course, very necessary, but quite often only the actual text need be read in order to obtain the information required. In this book the reader gets the best of both worlds because all the mathematics is in a separate section, thus leaving the text uninterrupted.

To the engineer this book will serve as a very good reminder of what he is attempting to achieve; to the student it forms an up-to-date tutor; and to anyone interested in this growing subject Crowhurst's book is excellent value.

A. M. BOWYER-LOWE

How Will They Weld?

Welding Handbook. 4th Edition. Edited by ARTHUR L. PHILLIPS. Section 4: Metals and Their Weldability. *American Welding Society, New York; Cleaver-Hume, London.* (72*s*)

It is usually possible to work up a good discussion on weldability as there is a vagueness about the subject which leaves plenty of scope for misunderstanding and argument. Even the term itself is ill defined, in spite of the efforts at definition by zealous national and international bodies. The specialist, particularly the specialist committee, tends to cover every possible shade of meaning, and ends with a definition as restrictive and confusing as it is pedantic. Laymen familiar with words such as portable and malleable would rightly suppose that " a weldable metal is capable of being easily and satisfactorily joined by welding."

Weldability is not a property capable of precise measurement except sometimes in terms of one particular defect or weld property. Discussions on weldability are, in fact, generally centred on the defect which is primarily responsible for limiting the performance of the welded joint. This might be a susceptibility to cracking or corrosion or the mechanical properties of the joint. When the weldability of a metal is studied specially designed " weldability tests " are often used to reproduce the limiting defect in a controlled manner, thereby permitting its investigation. Cracking is by far the most damaging of weld defects so that many weldability tests are cracking tests, and weldability itself is frequently thought of in this restricted sense.

Studies of weldability being related to weld defects are essentially welding metallurgy, but because weld defects are often influenced by the way a weld is made, welding metallurgy also embraces welding techniques. For example, a 0·2 per cent carbon steel is readily welded by the metal arc process, but in spot welding where the rate of cooling is much higher hard heat affected zones can result giving brittle welds. With this process the steel has poor weldability.

The weldability of a metal is determined by its composition and physical condition; a completely weldable metal being one in which welds indistinguishable from the parent metal in every respect can be made by any process. Such a material does not exist and in practice we can only approach this ideal by a careful control of the conditions under which a weld is made. This is done in three ways: (*a*) control of the materials used in welding, (*b*) selection of the welding process, (*c*) making the optimum choice of welding variables for the process selected. These decisions can be made best when there is an understanding of how welding process variables influence welding metallurgy. This is why welding engineers tend to be metallurgists!

Metals and Their Weldability, which is the title of Section 4 of the *Welding Handbook*, is not about weldability and welding metallurgy. No mention is made of how weldability is assessed or of cracking tests. There is, however, much useful practical information on how to weld a wide range of metals and alloys. The properties of parent metals are recorded in some detail and there are many references to joint preparation and design, welding techniques, torch manipulation and the treatment of welds. The book has a wider interest than the title would suggest and neither the welder nor the designer should be deterred from using it for reference. A keen

welder will find it a practical help when tackling the strange material. The designer will find an indication of what processes may be applied to which metals. He will also learn something of the snags and complexity of welding. The works metallurgist and welding engineer will value the book particularly.

The scope of the book will be made clear by noting the section headings in the 38-page chapter on austenitic manganese steel; they are: introduction, composition, heat treatment, cold working, metallography, properties of austenitic manganese steel, common applications and bibliography. There are altogether 15 self-contained chapters on different groups of metals, and it is an indication of the trend in engineering that there are many references to the less common materials, e.g. 54 pages on titanium and 15 on the precious metals. By comparison, the most common engineering material, mild steel, has not been treated so generously, meriting only five pages out of the total of nearly 600. Although there are still problems in the welding of mild steel the brief mention of the material is not so unjust as may appear. The chapters on welding metallurgy and properties of welded joints in Part 1 of the *Welding Handbook* deal in some detail with the weldability aspects of mild steel and it would have led to repetition to have included them in the present volume.

No one man could have written *Metals and Their Weldability*; in fact, bearing in mind that contributions have been necessary from so many experts, it is remarkable that the book should ever have been written. The difficulty of getting a busy specialist to put his experience on paper is only too well known. The result is a unique collection of practical information which, if it is not the last word, is certainly representative of the best informed opinion at present. What faults there are are those of the specialist; for example, a tendency to refer to materials by the code names he uses every day. In a book said to be a European edition it would have been extremely helpful to have had more references to filler metals and alloys by their metallurgical type, and surely it would not be unreasonable to expect references to temperature to be converted from fahrenheit to centigrade. As a treatise on metals and how to weld them this book is perhaps the most generally useful of the series and should be much used wherever welding is done and English is spoken.

P. T. HOULDCROFT

Concrete Tanks

Prestressed Concrete Cylindrical Tanks. By LEONARD R. CREASY. *Contractors Record Limited.* (35*s*)

The two requirements of a concrete water tank are that it can carry safely the loads applied to it, and that it does not leak. Mr. Creasy's book may be divided into two halves, one half dealing with each of these problems.

Of course these two requirements cannot be entirely separated. The great advantage of a tank which is prestressed is that the concrete is in compression, and remains so even when the tank is filled. But this alone does not always prevent leaks. The author discusses at some length the usual causes of seepage. The weakest point is where the wall joins the floor slab. It is possible to make the join monolithic, but this causes large bending moments at the foot of the wall. It is usually cheaper to build a tank with a pinned or a sliding wall. The author shows how these joints—which he calls "movement joints"—can be made in practice. He also discusses the types of contraction joints and construction joints which are most likely to remain waterproof, and he describes methods of introducing service pipes. In spite of all these precautions, it seems that leaks cannot always be avoided. A short chapter is included on how they may be repaired.

It is for the practical aspects of water tank construction that this book is especially valuable. Mr. Creasy has a great deal of experience in the design of water-retaining structures. The engineer who designs a water tank for the first time will find the structural design relatively easy. Books are not difficult to find on the analysis of cylindrical shells. However, since the tank must be watertight, the practical details become far more important than in ordinary concrete work. A certain amount could no doubt be found from various magazine articles, but the advantage of this book is that the knowledge is now so much more easily accessible.

The half of the book devoted to design is slightly less satisfactory. The author assumes a knowledge of the basic analysis of cylindrical shells, and merely tabulates the bending moments and shear forces as functions of certain variables. This is a pity, since the book is not long—it is only two hundred pages—and it would surely have been possible to make it more complete with a chapter on the basic analysis. As it is, the engineer who uses the tables is entirely dependent on the accuracy of the printers. And there are, in fact, a number of misprints throughout the book. There is a short bibliography which includes books where the analysis can be found.

Apart from this omission, the design section deals very well with the effects of prestressing the tank, and with the problems arising in all prestressing work, such as friction and stress losses due to shrinkage and creep. There is a description of various prestressing systems. It is pointed out that in practice the wall foot will never be completely fixed, since the floor slab can bend; a method is given for assessing the degree of fixity. The book is completed by two chapters of examples of prestressed concrete water tanks, in which the author gives a brief description of a large number of tanks from many countries.

This is an extremely well produced book, printed on good paper and well bound. The diagrams are clear, and there are some good photographs. It will be of particular value to any engineer designing a tank for the first time.

J. R. COLBOURNE

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Materials

Silicone Rubbers. MIDLAND SILICONES LTD., 68 Knightsbridge, London SW1. Brief summaries of the most important grades. 4 pp. unillustrated.

Plywood Shuttering. PLYWOOD MANUFACTURERS' ASSOCIATION OF BRITISH COLUMBIA, 1 Grosvenor Square, London W1. A folder outling economies which it is suggested may be realized by using Canadian fir plywood for concrete shuttering. Illustrated.

Stellite. DELORO STELLITE LTD., Stratton St. Margaret, Swindon, Wiltshire. A folder relating to a range of casting and hardfacing alloys. Particulars of the alloys are summarized, details are given of the service offered and the publications available on this material are listed. Illustrated.

Roofing Materials. RUBEROID CO. LTD., 1 New Oxford Street, London WC1. A folder giving particulars and specifications of Ruberoid copper roofing, manufactured from 42g copper sheet, with spherical indentations and a backing of filled bitumen. Three Series 3 information sheets; No. 9 referring to Ruberoid slates; No. 10 dealing with insulated metal deck roofing; No. 13 on Rubervent isolated and ventilated built-up roof. All illustrated.

Structural Steelwork. JOHN BOOTH AND SONS (BOLTON) LTD., Hulton Steelworks, Bolton, Lancs. A booklet on riveted and welded steelwork. Developments which have led to the lightening of steel structures and examples of different types of construction already completed or in course of erection. 20 pp., illustrated.

New Books

Business Consortia. By A. HARDING BOULTON. *Sweet and Maxwell.* (30*s*)

An essay on the nature of consortia and the legal, economic and administrative problems relating to their formation and operation.

Colour Television. N.T.S.C. System: Principles and Practice. By P. S. CARNT and G. B. TOWNSEND. *Iliffe.* (85*s*)

The British adaptation of the American NTSC system is fully described with special reference to the 405 line transmission (wherever there are differences between the 405, 525 and 625 line systems, these are fully explained). Both transmitters and receivers are dealt with, but there is special emphasis on the latter. For the service engineer, there is much practical information on the operation, installation and servicing of colour receivers. A familiarity with the principles and practice of monochrome television is assumed.

Stress Concentration Around Holes. By G. N. SAVIN. *Pergamon Press.* (84*s*)

This is a translation from the amended Russian text of 1959. Dr. Savin has collected together the most important results relating to stress distribution around holes and recesses in plates and beams subject to different kinds of loading, presenting them in a readily accessible form (simple formulae, tables and graphs) that will enable the engineer designer to draw conclusions and establish results without recourse to the detailed theory.

Handbook of Mechanical Wear. Edited by CHARLES LIPSON and L. V. COLWELL. *University of Michigan Press, Ann Arbor; Creset Press, London.* (£7)

The lectures contained in this volume comprise the short course on wear, held at the University of Michigan. The material is presented in six major groupings: Fundamental aspects of wear; Pitting, scoring and spalling; Corrosion; Abrasion; Wear resistance materials; Manufacturing proccesses.

Porcelain Enamels. By ANDREW I. ANDREWS. 2nd Edition. *Garrard Press, Champaign, Illinois.* ($12)

Exhaustive and authoritative treatment of the preparation, properties and applications of enamels, prefaced by a historical survey.

The Reviewers

Mrs. M. Neal, B.Sc., D.I.C., A.F.R.Ae.S., had many contacts with test-flying personnel during the war years at the Ministry of Aircraft Production where she held the position of technical officer. Later she took up technical journalism, joining the staff of ENGINEERING, and is now a free lance.

Dr. D. J. K. Stuart is chief research engineer of the British Motor Corporation. He was previously senior technical assistant on transmissions and internal combustion engines with the same company and had earlier been engaged in gas turbine development in Armstrong Siddeley Motors.

Mr. A. M. Bowyer-Lowe, M.B.S.R.A., served his apprenticeship with Pye Limited, where he is now audio development engineer. He has been designing and constructing audio equipment since he was 12.

Mr. P. T. Houldcroft, B.Sc., is chief metallurgist at the British Welding Research Association, with main responsibilities in non-ferrous and welding process research. He is a Fellow of the Institution of Metallurgists.

Mr. J. R. Colbourne, B.A. (Cantab.), is a structural engineer with the consultant firm of Ove Arup and Partners. His technical studies were augmented by a year at the Technische Hochschule in Darmstadt.

Marketing

Selling to France

About 100 senior British executives, associated with banks, engineering, advertising and the manufacture of consumer goods, met recently to assess the divers problems encountered in selling to the French market. The meeting was arranged by Adam Johnstone, chairman of SALES AUDITS LIMITED and three Frenchmen, each an expert in his field were flown from Paris to give advice.

At the close of the Conference, the general consensus of opinion was that British products could sell profitably in France provided the correct approach to promotion was made. Few British firms are well known in France and sales efforts are seldom extended outside Paris and other major centres.

A healthy export market depends largely on a universal knowledge of the particular product concerned and in his criticism, Mr. Gerard de Ligny said that the average French housewife or industrialist rarely buys British, not for reasons of prejudice but more because of his unfamiliararity with British goods. Such a situation could only be rectified by increased publicity.

John Lyons, marketing director of Girep Sodirep in Paris, stated the position thus: "The French market is a complex one with highly individual characteristics; unless a British firm is willing to study the market thoroughly and then key his production, packaging, promotion and sales effort to the market demands, there is little chance of success." He went on to say that our overseas competitors were taking the trouble to do this and a valuable market would be lost to British goods if this practice was not emulated.

The two-day study concentrated on the specifics—what marketing policies to adopt; which selling and advertising to use; how to package and promote a product.

It is intended to hold studies of the Italian, German and Scandinavian markets in the near future.

The Sixth Beama Publicity Conference

The British Electrical and Allied Manufacturers Association held its sixth annual publicity conference at the Connaught Rooms on 7 and 8 November.

Six sessions comprised the proceedings which included a discussion on publicity overseas, a general question time and three papers covering a broad cross-section of the many aspects of publicity. These were "The Company Image" by Brian F. MacCabe, chairman and managing director of Foote, Cone and Belding Limited; "Publicity: Vital Ingredient in Marketing" by C. A. Ganderton, marketing director, AEI-Hotpoint Limited and the "Law in Relation to Advertising" by W. J. Leaper, secretary, Solus Outdoor Advertising Association.

Each session provoked much lively discussion and numerous questions from the delegates who numbered around 200.

All the speakers emphasised the ever-growing importance of publicity and advertising in sales promotion but to quote Mr. Ganderton: "It will only fulfil its vital role if the top management of the company recognizes the potential of advertising, giving it a major place in the management structure, and educates heads of all departments in recognizing advertising's role. Unless this is done, advertising will be a mechanical service function, not a creative one—certainly not a vital ingredient in the company's marketing."

Mr. Leaper in his illuminating talk stressed the importance of ensuring that statements of fact were accurate and drew attention to the many dangers concerning copyright and defamation, illustrating these with some interesting and sometimes amusing examples.

The guest speaker at the official luncheon on the second day was the Hon. H. G. Nelson, managing director of the English Electric Company Limited. In a well-prepared speech, Mr. Nelson outlined the difficulties to be encountered by an industry which is expanding rapidly and facing rising costs whilst trying to keep its prices down. In addition, increased world competition and the growing trend towards overseas manufacture were moving the industry towards an unstable condition where there were shrinking profits in relation to the capital employed.

He went on to say that these difficulties must be faced by rationalization, increased cooperation and an improvement in deliveries. After-sales service was a vital ingredient of success as was a healthy home industry. Costs must be kept down but this must be done by improved methods. There must be no decline in quality or reduction in research and development effort.

British Turbines for Australia

Among the successful contractors for the generating plant to be installed at the Murray I power station are BOVING AND COMPANY LIMITED of London. Through their Australian subsidiary company, they are to supply eight 130,000 hp vertical Francis turbines to operate under a maximum gross head of 1,719 ft, which is believed to be the highest in the world for this type of equipment. They will run at 500 rpm. The value of the contract is in excess of £1½ million and it includes a rotary valve and pressure relief valve for each turbine.

Manufacture will be undertaken partly in Australia and partly in Britain by MARKHAM AND COMPANY LIMITED of Chesterfield, who are currently employed on other projects for Boving including work on the five Pelton turbines and two Francis turbines for Barron Falls, Queensland.

Power Tool Firm's Middle East Campaign

BLACK AND DECKER LIMITED, the power tool manufacturers, culminated their sales campaign in the Middle East with a stand at the Damascus Trade Fair held from 24 August to 20 September. No other British firm was represented.

Commencing with the Beirut Trade Fair in early June the campaign continued with a comprehensive tour of Iran, Saudi Arabia, Kuwait and other Persian Gulf countries. Of its possibilities, Mr. J. C. Brooman, export sales director, said: "The area covered is the greatest potential market still available outside Western Europe and the American continent, yet neither the Government nor the British industry as a whole seems to be giving it the attention it deserves." He went on to state that the predominant exhibitors at Damascus were Eastern bloc countries and implied that these would gain prominence in the market if the complacent Western attitude was maintained. The latest balance of trade figures showing deficits exceeding £100 million emphasize the need for improving exports to the Middle East countries.

Black and Decker appear well pleased with the results they have obtained and have now embarked on a similar tour in Malta and the North African countries with a view to establishing a stronger distribution network and to follow up the inquiries from this area.

New Factory for Aerograph DeVilbiss

Owing to the need for enlarged manufacturing facilities, the AEROGRAPH-DEVILBISS COMPANY LIMITED have had built a new factory and administrative premises at West Howe, Bournemouth, Hants. The company's interests include spray guns, air compressors, automatic spray coating machines, portable spray painting plants, paint heating units and a wide range of spray booths. Production of all these has been transferred from the premises at Lower Sydenham.

In addition, the head office, sales division and export department have moved, together with an enlarged spray painting instruction school and a demonstration and customer research centre. The existing Holborn Viaduct sales office will continue to handle business in London and the Home Counties.

The new building which has been specially designed to facilitate further expansion when necessary, is 520 ft long and 170 ft wide and has been built by RICHARD COSTAIN (CONSTRUCTION) LIMITED.

English Electric Turbines for American Dam

THE ENGLISH ELECTRIC CORPORATION of New York has been awarded a $2½ million (£900,000) contract for the supply of four Kaplan water turbines for installation in the new dam and power station on the Grand River at Markham Ferry, Oklahoma.

Each will have a runner diameter of 220 in and will develop 35,000 hp at 90 rpm. They will be manufactured to English Electric design by JOHN INGLIS LIMITED of Toronto, an associate company. The design work will be undertaken by the company's Hydro-Electric Division at Netherton and model testing and development will be carried out in their hydraulic laboratory at Rugby. The consulting engineers for the project are W. R. Holway and Associates of Tulse, Oklahoma, who have also been responsible for the construction of an earlier dam at Pensacola on the Grand River.

The new dam is to be a gravity and rock filled project operating at a mean head of 55 ft. In addition to providing a degree of flood control for the surrounding countryside, the power station will supply the State of Oklahoma with a further 100,000 kW of electrical power. Operation of the power house is scheduled for commencement in May, 1964.

British-East-German Trade Increase

Figures published by the Board of Trade show that British trade with East Germany is continuing to increase in volume. Total trade including re-exports for the first nine months of 1961 amounted to £12,783,486, an increase of £1¼ million over the corresponding figure for 1960 and more than £6½ million above that for 1959.

Of this exports and re-exports comprised £7,531,284, the figures for the previous two years being £6,389,483 and £2,727,383. Imports into Britain from East Germany at 30 September totalled £5,252,202 compared with £4,694,138 for the same period in 1960 and £3,423,611 in 1959.

As can be seen the figures reflect a healthy trend, and the prime increase in trade has come from the export side. Import figures have increased steadily but far less rapidly than exports, which have almost trebled in two years.

AEI at the Indian Industries Fair

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED occupy the largest stand taken by a private firm in the United Kingdom Pavilion at the India Industries Fair which opened in New Delhi on 14 November. It will continue for six weeks.

Designed by V. Rotter of Publicity Planning Limited, the stand takes up 2,000 sq. ft and displays working models, films and other devices to show some of the range of 3,500 types of equipment which AEI make and distribute throughout the world. The theme of the display is the part played by the AEI in the Indian industrial revolution and the general development of power.

A large map shows the location of eight main projects on which the company has been engaged, one of which is the £85 million heavy electrical plant being built at Bhopal by the Indian Government with AEI as consultants.

The firm's Indian subsidiary, Associated Electrical Industries (India) Pvt., have a section showing a wide range of motors, from 1 to 500 hp, transformers, tap changing switches, fuseboards and associated equipment. Surrounding this is a perimeter display of AEI activities throughout the world, and an illuminated map pinpoints the company's 70 factories and four research laboratories in the UK. Details of work of a varying nature undertaken in five continents are shown on a rotating drum.

AEI's work in the electronics field is represented by a 21 in Ekco television set, a computer plug-in board and a wide range of control and test equipment. A nuclear development section highlights a photograph of the "hot" metallurgical laboratory at Wythenshawe and an animated flow chart of the Berkeley power station.

XUM

The BMC "Minis"

Problems of decreasing size and increasing economy in the small car are capable of many solutions. One of the least orthodox is a great success.

How many British Motor Corporation Minis did you see on your way to work this morning? The chances are that they represented a high proportion of all the cars you saw.

Production at Longbridge has just passed the quarter million mark—a remarkable achievement. The Mini (in Austin and Morris forms) was only introduced two years ago and since then it has persistently confounded its critics and exceeded the expectations of its creators. It can reasonably look forward to going down in history not merely as one of the most popular British cars ever produced, but also as the biggest motoring revolution of the nineteen-fifties.

The Mini's astonishing success is due purely and simply to good engineering. Bold and imaginative design was aimed realistically at a known need. The result is an original and unconventional product which is winning laurels to a degree that would have been most unlikely with a more orthodox approach. That is not to say that the various earlier Morris Minors and Austin Sevens were not outstanding successes—they undoubtedly were. But in creating the Mini the BMC knew that they could not hope to retain their traditionally strong position in the small car market by continuing with scaled down versions of larger cars with an orthodox layout. It was time for something new.

The Continental manufacturers' answer to a growing postwar demand for the small car took the form of a vehicle with the usual rear wheel drive, but with an air-cooled engine rear mounted to simplify the transmission. This arrangement necessitated front mounting the luggage boot, and led to a new and highly saleable low-fronted styling. For several years the British car industry was under continuous fire for not following the Continental line, and much home and overseas business was lost to Central European manufacturers. But the heavy criticism abruptly ceased when the Mini appeared—and much of the lost business, particularly in the home market, has since been regained.

The immediate effect of the Mini may have been pacification, but it also served as a refreshing reminder that there are other answers to small car design besides the Continental form. The British Motor Corporation persistently refused to accept it as being the best answer for British conditions. But it is one thing to reject a principle and quite another to find a better one, and the BMC were themselves unsure of the right answer. They preferred to wait and be sure rather than be too hasty and later sorry. But the wisdom of this policy in view of the valuable ten years which elapsed before the Mini appeared will no doubt be debated for many years hence.

The main point about the Mini is that it is so outstandingly successful that it has already gone a long way towards catching up the lost leeway. Its conception was a flash of inspiration on the part of Mr. Alec Issigonis, BMC's chief designer, who had been responsible for the earlier Morris Minor, later the 1000. He suddenly, almost overnight, conceived a plan for a new light car. He had no difficulty in conveying his enthusiasm to his managing director, Sir Leonard Lord, who unhesitatingly gave approval.

THE BASIC CONCEPTION

It is worth examining the basic conception in detail. The prime factors in producing a successful small car are:

(1) Low selling price.
(2) Economy, in fuel and upkeep.
(3) Unobtrusiveness, for mobility and parking.

Keeping down the cost is an evergreen problem but it attains greater prominence with an unorthodox conception like the Mini. A mass-produced motor car today probably requires an investment of about £5 million in special tools, or half the capital cost of production. The designer has therefore to find suitable well-proven components already in full production and build up the design from them. In the case of the Mini, Mr. Issigonis had no need to introduce a new engine and gearbox unit; he simply used them in a new way.

He also used the notably economical "A" series engine reduced from 950 to 848 cc by shortening the stroke, in conjunction with the much lighter vehicle. Routine maintenance was reduced to the minimum by the extensive use of rubber for the suspension mountings and, incidentally, by the integration of the engine and gearbox.

But the low cost principles are well known: they are not in themselves as revolutionary as the way they have been applied to the Mini to offer such compact exterior dimensions, yet with room for four adults to travel in comfort.

What is the ideal small car? It is a box on four wheels with thin transparent sides affording the maximum interior space with the minimum outside dimensions. It must be able to move at any speed and in any direction as dictated by the driver. The four wheels must be placed one at each corner and have independent suspension in order to offer the maximum stability and road holding. Impossible, you will say—but the extent to which these ideals have been approached in the Mini will surprise you.

Designing a passenger-carrying box presents no difficulty, nor does keeping the sides thin by confining the body structural members to positions within the basic envelope so that they least interfere with passenger comfort. Placing the wheels at each corner, keeping the track as wide as possible, also assists in leaving an unobstructed interior, and offers no appreciable difficulties. It is when the designer reluctantly has to provide a place for the engine, and also give the car the greatest directional freedom that his troubles really start.

The solution found for the Mini is well known. The in-line overhead valve water cooled engine lent itself to transverse mounting. The philosophy of coupling the engine and the driven wheels together at the same end of the car was essential for the Mini, but the question remaining was, which end? Both have drawbacks, but steering and driving on the same pair was considered essential. The chief drawback to this arrangement is the physical difficulty of reconciling the two functions without operational sacrifice. In the Mini certain resulting complications were considered well worth paying for, the key to the final solution lying in designing a constant velocity universal joint for connecting the drive shaft to the front wheel. Rubber plays a leading part in the drive shaft assembly.

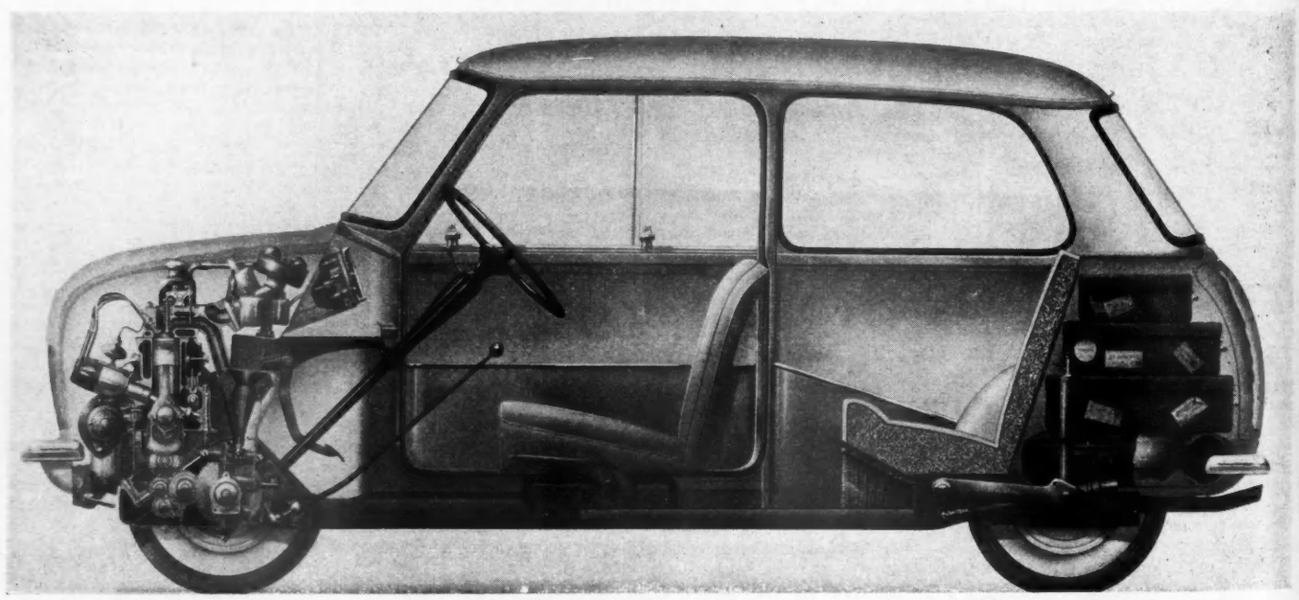


Fig. 1 Making the best use of available space.

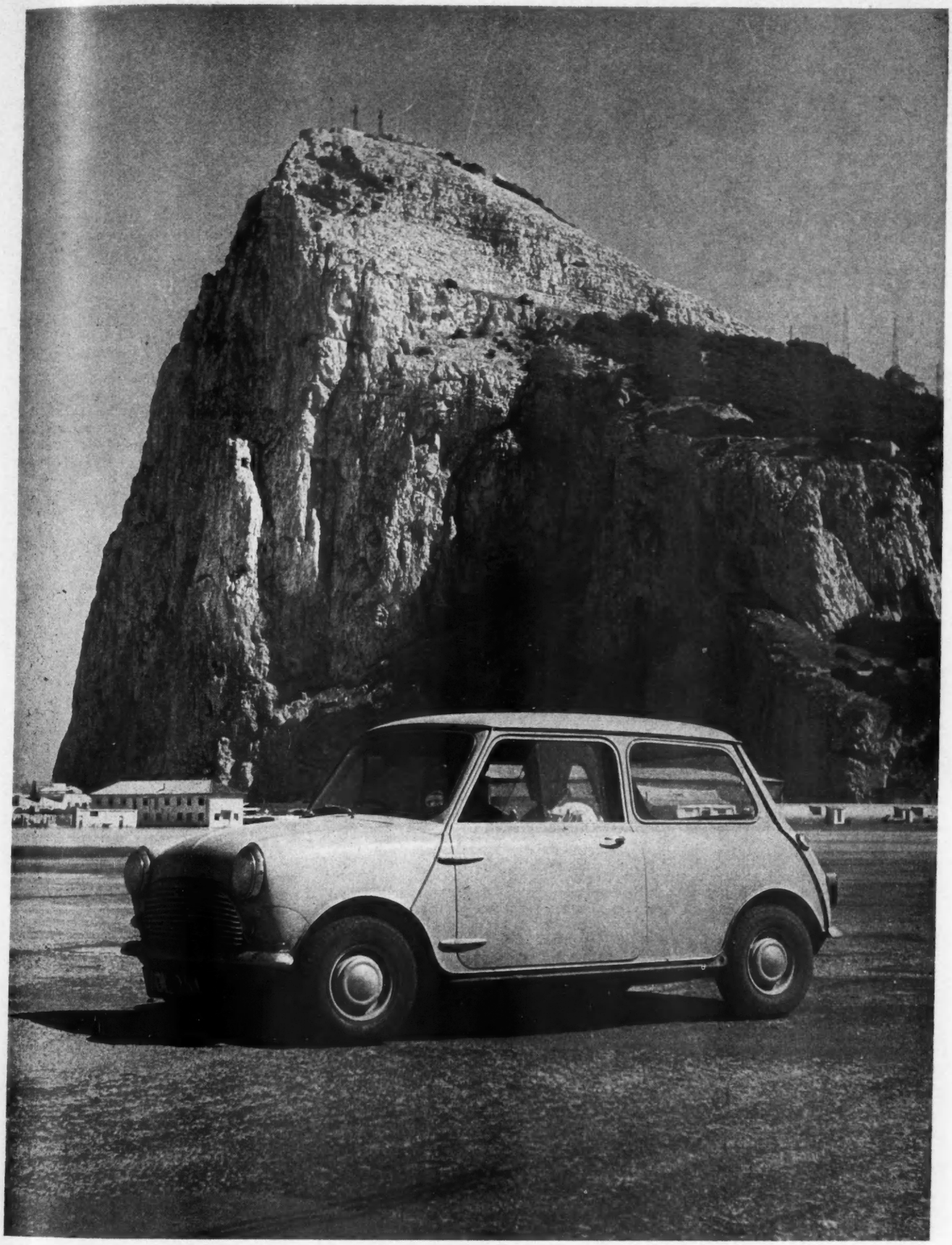


Fig. 2 The crowning success of an organization traditionally associated with a particular section of the market.

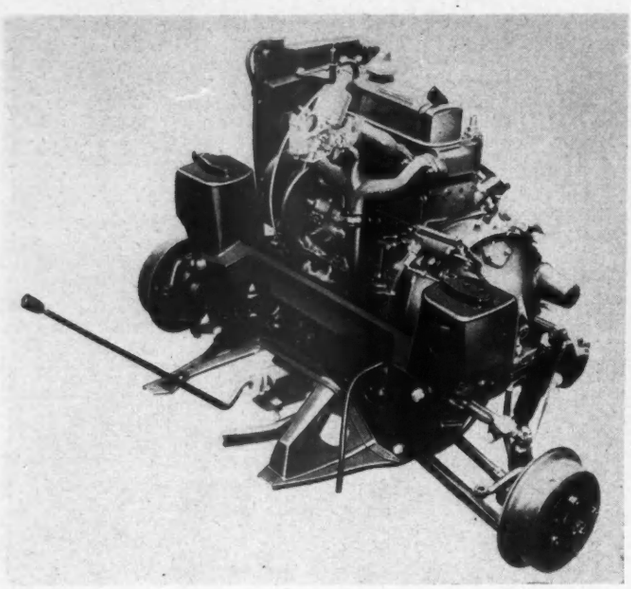


Fig. 3 (left) Front sub-frame with power unit and suspension.

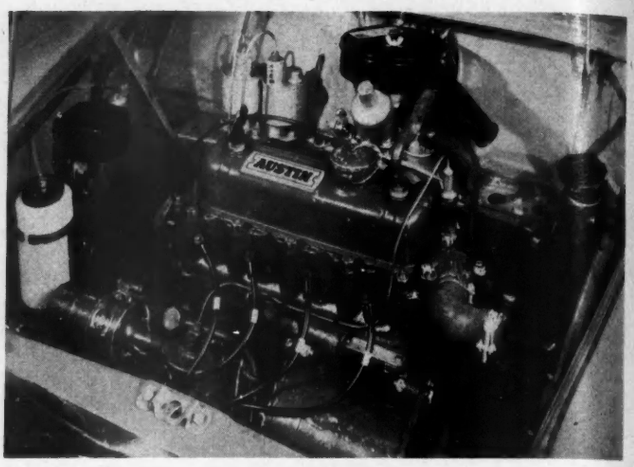


Fig. 4 (above) Even the position of the radiator is unconventional.

But it is in the compactness of the complete power unit that the Mini's design really scores. To save space the gearbox and final drive differential were incorporated in the engine sump, with a pair of short open drive shafts leading to the constant velocity joints, as shown in Fig. 3. And the ingenuity of the arrangement does not rest there. The independent front suspension units have swivel axles mounted on ball joints and the levers are of unequal length to prolong the life of front tyres by eliminating "scuffing" on corners. Above each top lever is mounted a Moulton rubber spring and hydraulic shock absorber, and fore and aft location of the suspension units is maintained by tie-rods. The four-speed gearbox has synchromesh engagement on second, third and top gears.

The Moulton rubber springs offer a variable rate in the simplest possible way, and have a virtually indefinite life. Though the Mini was designed around the twin factors of fuel economy and compactness, and was expected to appeal particularly to the ride-to-work man, the suspension was designed to withstand sustained high speeds in perfect safety on much rougher roads than are normally encountered.

A controversial topic which arose anew when the Mini first appeared in August, 1959, was the question of an air-cooled versus a water-cooled engine. The air cooled unit tends to be lighter and the water jacket is eliminated, but it also possesses serious drawbacks. Perhaps the most important is that by the time a cooling fan of adequate capacity and air ducting have been added, the bulk of the engine is greater than that of a comparable water cooled unit.

Fuel economy also enters into the matter. It is impracticable to air cool adequately a car engine with a compression ratio greater than about 7 to 1, whereas the Mini uses a ratio of 8·3 to 1. Up to a point the higher the compression ratio the greater the fuel economy, but the question of engine rpm and the final drive ratio in top gear are also critical. The Mini has a relatively high final drive ratio of 4·5 to 1, enabling the maximum use of top gear at lower speeds. Other advantages of water cooling are the mechanical quietness, the heat reservoir around the engine for easy starting between stops and an effective link-up with the car's internal warming system.

A low road space factor would be of no advantage without good manoeuvrability. With an overall length of only 10 ft and a turning radius of less than 16 ft, the Mini can be parked in a gap of 11 ft 6 in. A good steering lock is matched by the visibility afforded by the sliding panels in the door windows.

Even such an inherently *right* conception as Mr. Issigonis' Mini depended upon impetus from an outside factor. In 1957 the BMC were considering developing a new design but were undecided as to its size. When the Suez crisis occurred no car bigger than 7 hp could be sold in Britain, and the propitiousness of the moment for introducing a small car to beat all small cars was suddenly recognized. The Corporation were not only thinking of the sordid commercial angle; they were also conscious of the need for a quantity produced high economy car in order to be reasonably sure of keeping their staff employed, even during conditions of fuel shortage.

PERIOD OF DEVELOPMENT

Apart from reducing the tooling costs by half, the use of existing components led to the short period of development of just over two years. As usual the situation called for successful communication. For how can the designer be expected to convey his ideas and have them interpreted correctly by the thousands of workpeople affected, except by gaining their confidence at every stage by personal contact? It is a natural tendency to criticize the designer.

Another illustration of the unconventional nature of the Mini is the way it fits into the car selling pattern. If the cost per lb weight against actual selling price be plotted graphically for private vehicles from the motor cycle combination to the Jaguar and the Rolls-Royce, the resulting curve will take the form of a U. The most popular cars mostly lie around the lowest portion of the U, but the Mini lies well up one side of the curve in the less expensive region. It is worth speculating whether it may be taken as a portent for the world's car industries as a whole.

This Product Profile would not be complete without mention of the new Cooper. The 90 mph Mini Cooper is a "hotted up" version of the basic Mini which reflects a change in public attitude as to the way the basic Mini structure ought to be used. Though the Mini proper was provided with a low centre of gravity and other features contributing to good road holding, its creator never advocated it for fast long distance travel despite a top speed of 73 mph; it was intended more as an about-town runabout.

However, the mere fact that the body and chassis design has characteristics built in that enable high speed running to be performed without danger or discomfort has led to a section of Mini users who want to use them to the full. It is for them that the Mini Cooper has been evolved. The same basic engine has been increased to 997 cc, plus disc front brakes and other minor modifications. No manufacturer wishing to keep a lead he has gained over his competitors can afford to ignore the dictates of public demand.

Of all the world's car manufacturers, perhaps the BMC offers the widest variety. This policy is directly at variance with that of certain foreign manufacturers; the Mini, for instance, offers direct competition with all makes of larger cars including the BMC's own products.

The increasing importance of styling in cars is another controversial matter, and the tendency is for more money and effort to be devoted to it. In contrast the Mini represents the complete fulfilment of the *engineer's* art, right down to the body radii and the colours. If the design breaks away sufficiently from convention it does not need styling in the sense of blending into the fashion of today—instead it sets a new pattern to be followed tomorrow.

The British Motor Corporation Limited, Longbridge, Birmingham.

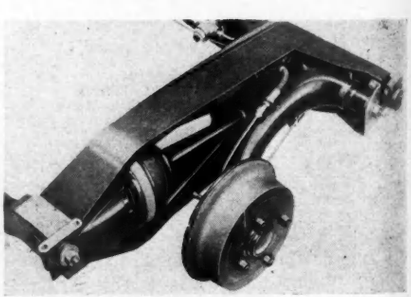


Fig. 5 (above) Rear suspension unit.

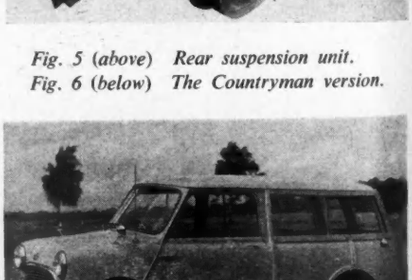


Fig. 6 (below) The Countryman version.

Mechanical Properties of Foils

Precipitation-hardening stainless steels are widely used, particularly in aircraft, but the metallurgical reactions that occur on heat treatment of these metals are not completely understood. The US Bureau of Standards has been conducting a study of these reactions and their relation to the mechanical properties of the steels.

For certain phases of the investigation, it was desirable to use the material in the form of a foil because of its ability to heat and cool rapidly. Moreover, a large number of specimens can be made from a single sheet of the foil, thus eliminating variables due to differences in specimen composition.

However, the preparation of foil specimens for tensile of micro-hardness tests is tedious and time consuming, and the edge effects that are sometimes introduced by this preparation give misleading results. Experiments were conducted, therefore, to see if another type of test could be devised which would provide the required data on mechanical properties without these difficulties.

The results of the study showed that a hydraulic bulge test of a disc specimen gives satisfactory data on changes in yield strength and ductility of the foil. The principle advantages of this technique are the ease of specimen preparation, the small amount of material required, and freedom from edge effects. The hydraulic tester employed for the study was assembled from commercially available high-pressure equipment. To conduct a test, specimens of 0·72 in diameter, punched from the heat treated foil with a carefully constructed punch, are mounted in the apparatus by means of a hold-down ring and bushing having an inside diameter of 0·533 in. Oil pressure is then applied to the specimen by means of a manually operated pressure cell; the resulting bulge in the unsupported area of the specimen is measured with an optical micrometer arranged to follow the movement of a lightweight indicator resting on the centre of the specimen.

Tests conducted on a series of specimens after differing heat treatments showed that the bulge height at failure was an adequate criterion of ductility. To obtain a suitable measure of yield strength, it was necessary to determine the permanent bulge height (after release of pressure) for a series of increasing pressures. The criterion of yield strength was arbitrarily chosen as the pressure that would cause a permanent bulge height, h, such that $h^2 = D^2/2{,}000$ (where D is the unsupported diameter), and this is referred to as the yield pressure.

Test results show that yield pressure and maximum bulge height are sensitive measures of the effects of various heat treatments. Even the most brittle specimens, such as those which have been nitrided in addition to receiving other heat treatments, have sufficient ductility to permit accurate determinations of yield pressure.

Choosing a Research Reactor

Although some 130 papers were presented at a symposium on "The Programming and Utilization of Research Reactors" organized recently by the International Atomic Energy Agency, much of the discussions centred around the theme of advice to underdeveloped countries and others, such as universities, on how to set up a nuclear reactor centre.

The first question discussed was what power of reactor should be chosen. Although an international body rarely reaches a definite conclusion, it did appear that if a country could contemplate only one research reactor, then it should be in a 1 to 5 MW range with a neutron flux of 10^{13} neutrons per sq. cm per sec. Where more than one reactor can be envisaged, a low power reactor in the 10 to 100 kW range could fulfil a most useful role in training and could do much useful research. In particular, the comparatively cheap low-power reactor would be valuable in the building-up and training of technical staff while a bigger reactor is designed and constructed. This in fact is the scheme being adopted by Holland at their Reactor Centrum Nederland, at Petten.

No definite preference for a given type of reactor was shown although it was agreed that in the 1 MW range the swimming pool type has been found to be very convenient. For the 10 to 100 kW range interesting programmes of research being carried out on both the Argonaut and Triga types of reactor were described. A shrewd comment on reactors in the one megawatt power range was made by a Russian delegate, to the effect that the higher power reactor has tended to become complicated and the auxiliary equipment elaborate and expensive. Simplification might well mean that an increase in the numbers of this kind of reactor could become a financial possibility. Provision for future increase in power and flexibility of the design of the reactor should also be a prior consideration in choosing a reactor.

The selection of a programme of research for a new small-scale centre was considered to be difficult for both the underdeveloped and the more fully developed countries. In the early days reactors primarily carried out nuclear physics research but today much work is on technology, biology and chemistry. A view was expressed by the Egyptian delegate that the small centres should not try to compete on topics of world-wide interest for which their reactor may be inadequate. For example, cancer research is under active study by the developed countries which have the most powerful and most suitable reactors at their disposal. The small centres should try to work on topics of special concern to their own country; for example, pest control on principal crops. It was also pointed out that programmes which lead to the development of new techniques but which may not lead to new results are valuable and should not be discouraged.

Much stress was placed by all delegates on the need for cooperation between centres and between individuals. Two types of grouping of centres were suggested by an American delegate. One was the partnering of an advanced research centre with a group just starting; the other was the grouping of those with equal ambitions and similar interests. As an example of this the case of Norway and Switzerland was cited as they are both interested in water-moderated assemblies. For the sake of confirmation of data it is desirable that a given topic is investigated in more than one research centre and in such cases cooperation between the individuals concerned should include an exchange of visits to each establishment. The hope was expressed that the International Atomic Energy Agency would help further in this direction by publishing lists giving particulars of research being carried out on different problems.

Participants at the symposium from universities were most interested in the programme of research being carried out on the 1 MW swimming pool reactor at the Technische Hochschule München (Munich). This reactor is operated 16 hours per day, five days a week, mainly for the education of students through postgraduate research. Most of the research work is done by advanced students working for a doctorate who, in many cases, have to rely on their own initiative and judgement. At present about 60 research students are working on the reactor. Their efforts are on pure rather than applied research problems and the whole arrangement seems to be most successful.

Furnace Brazing in a Vacuum

The practical value of brazing in a vacuum rather than a protective atmosphere has been proved and widely accepted. Nevertheless, the development in the United Kingdom of furnaces suitable for commercial vacuum applications is comparatively recent. Brazing in a protective atmosphere (usually super-dry hydrogen) with some materials can only be effective when the reducing gas can be made and kept sufficiently dry to purify the surfaces being joined. Reactions between the gas and the furnace wall can produce sufficient water vapour to contaminate the atmosphere above a tolerable level. However, the vacuum brazing technique eliminates this problem and realizes other definite advantages, such as ease of joint preparation and an improvement in joint ductility, by preventing the absorption of gases.

Vacuum Research (Cambridge) Limited, have recently developed and built a resistance-heated high-vacuum brazing furnace for the Services Electronics Research Laboratory, Baldock, Herts. The specification called for an auto/manually controlled resistance heated hot zone, measuring 11 in high by 12 in wide by 24 in long. A maximum operating temperature of 1,300° C was requested. The charge weight at this temperature is 20 lb, evenly distributed along the hearth. At a lower temperature of 1,100° C, the maximum charge weight is increased to 80 lb. It was necessary to provide an extremely clean system, capable of operation at less than 10^{-4} mm Hg pressure.

The maximum power consumption required by the plant is 46 kVA, at 415 volts, 50 c/s, three phase. The furnace unit is fed by a three phase, delta wound transformer at 44·5 volts. Power control is by a signal fed from a thermocouple via a temperature controller to a magnetic amplifier and saturable reactor.

The high-vacuum pumping system is a completely self-contained mobile unit which may be removed for servicing. All pipework and components exposed to pressure below 1 mm Hg are made of stainless steel internally electropolished.

An isolation valve, liquid nitrogen trap and water-cooled chevron-type baffle are mounted on a stainless steel mercury vapour diffusion pump, which is backed by a gas ballasted mechanical pump. The vapour pump can be held by an additional rotary pump whilst the chamber is "roughed" out. The rotary pumps are fitted with sequenced air admittance and isolation valves to prevent air or pump oil from entering the vacuum lines.

The unit provides an ultimate vacuum better than 10^{-5} mm Hg and has a pumping speed greater than 300 litres per sec at a pressure of 10^{-4} mm Hg.

Deterioration of Electrical Insulation

Deterioration of electrical insulation occurs in many ways. By developing means of preventing it or of predicting its effect, reliability of electrical equipment can be improved.

MANY of the investigations carried out by the six departments of the ERA either directly or indirectly concern electrical insulation. In the Materials Department the emphasis is upon the properties of insulation and an important function of these properties is their variation with time. Straightforward tests will ensure that an equipment is satisfactory when it leaves the factory, but the user wants to know that it will still be working in several years' time after enduring a variety of hazards. The causes and the rates of deterioration must therefore be found.

Deterioration is the result of one or more of at least three processes; electrical discharges, electrochemical or chemical change; and heating.

Electrical Discharges

Discontinuities, such as air pockets and gaps in the body of the insulation, cause concentrations of electric stress which may be sufficient to initiate discharges. These give three types of deterioration in solids: (*a*) chemical attack by ozone and nitrous oxides in the surrounding air; (*b*) erosion by impact of ionized particles; and (*c*) the propagation of breakdown channels by high localized electric stress at their ends.

In every case, the long-term effect is to reduce the thickness of the insulation and cause failure. Experiment has shown ways of discriminating between good and bad materials and of predicting life by short-time tests.

When insulation is subject to a c stress sufficient to cause discharges, the number of discharges per cycle is theoretically and experimentally independent of frequency, provided the products of the discharges do not alter the electrical properties of the cavities. Thus the effects of years of discharges at 50 c/s can be condensed into a few weeks by using a higher frequency. If, however, too high a frequency is used, excessive heat is produced and leads to breakdown by thermal instability, while the release of decomposition products can short-circuit the cavity and suppress the discharges. The maximum frequency for solids ranges from 500 c/s for phenolic-bonded glass-fibre laminates to 1 Mc/s for polyethylene, and depends on their power factors, chemical properties and the thermal conditions.

Rigid insulation has been tested with several types of specimen and electrodes. An early arrangement is shown in Fig. 1a. Two discs of the test material, one of which has a cavity moulded or machined into it, are clamped between brass electrodes and the whole immersed in oil to prevent flashover. Discharges occur in the cavity and eventually lead to breakdown. A "flow cup," as specified in British Standard BS.771, proved to be a very useful specimen for evaluating moulded materials. The cup and the stainless steel electrodes, in Fig. 1b, can be used in dry air because of the long flashover path. Although it is also a useful research tool the simple rod-plane system in Fig. 1c is preferred internationally for specification purposes. If thin or yielding materials are tested the rod is supported a few microns above the specimen to prevent mechanical damage or deformation.

Any evaluation of life must refer to specific materials since there are so many variations of any one type of material, caused by different formulations of resins, fillers, etc. Fig. 2 gives life curves for some typical materials.[1]

Breakdown across the surface of a dielectric (tracking) is not always caused by discharges. It can be the result of localized heating of the surface by leakage currents through dirt or moisture films. Frequently however there is surface erosion by discharges. These discharges occur at the ends of carbonized paths where the stress concentration is high, and extend the path until a complete breakdown occurs. Tests exist which discriminate between good and bad materials but they are generally erratic, tedious to do and expensive in man-hours. The ERA has developed an automatic tracking comparator[2] which simplifies the selection of materials that will have long lives under conditions favourable to tracking. The IEC test method is employed, but improvements are made and the whole process is automatic.

Drops of a standard salt solution fall at 30-second intervals between two brass wedge electrodes held by weights onto the horizontal specimen. A "comparative tracking index" is obtained from a curve of the number of drops to cause failure of the insulation against the voltage applied between the electrodes. Accurate control of the drop size and rate makes the test more reliable, and there is an automatic record of the number of drops.

Discharges are not confined to solids, and users of liquid dielectrics meet this hazard. Cables, capacitors and transformers impregnated with insulating liquids are used extensively. Solid insulation—which is usually paper—is impregnated to increase its electric strength and eliminate the stress concentrations caused by gas pockets. When impregnation is complete the life under a c stress is generally long, but if discharges above a certain energy level occur they increase rapidly and cause failure.

The ERA's approach to this problem has been twofold. A method of detecting discharges has been developed and the causes of the discharges are being investigated. Two types of discharge detector[3], which are available commercially, measure the voltage E_i at which discharges first occur. The acceptable discharge inception voltage depends upon the nature and condition of use of the equipment but if E_i is about three times the working voltage the equipment is unlikely to fail because of discharges. This factor of 3 legislates for the transient voltages inherent in a c networks. Operators using the detector can often judge the cause of discharges and so improve design, but they must also ensure that discharges are not from outside sources. Electrostatic screening and filtered mains supplies are essential.

It is largely due to the ERA's work that the International Electrotechnical Commission specification for shunt (power factor correction) capacitors and series (transmission line) capacitors now includes clauses requiring freedom from discharges greater than 50 pCoulombs at 1·5 times the working stress, after the application of a transient voltage specified in each case.

Life can be increased if the causes of discharges are removed. This is not always simple, but considerable advances have been made in understanding the problem. The onset of discharges in a fully impregnated oil-paper system was found to coincide with the sudden appearance of a gas bubble in the oil. It is well known that the presence of a bubble causes discharges with the formation of more gas, but the origin of the initial bubble was not apparent. Experiment showed that in a vacuum-impregnated cellulose-oil system the voltage at which the first bubble appeared decreased as the moisture content of the cellulose rose. Other hydrophilic materials in oil behaved similarly, but solid dielectrics with low water absorption did not initiate gassing. Other insulating liquids were tried but did not influence these results. The bubble must therefore come from the hydrophilic solids or their absorbed water. Better drying of the insulation, therefore, will increase the life of the equipment, and Fig. 3 shows the increase in E_i of a 40 micron thick rag-paper and oil system resulting from drying the paper.[4] The resistivity is a measure of dryness and the highest resistivities shown correspond to less than 0·1 per cent of moisture.

The gas in the initial bubble is undoubtedly hydrogen and oxygen from electrolysed water; this gas is found at points of stress concentration where conductivity is enhanced locally by electron emission; but more gas is ultimately produced than could come from the absorbed water. This originates from chemical decomposition of oil and cellulose under bombardment by electrons and ions from the discharge.

Electrochemical and Chemical Deterioration

In the previous paragraphs dealing with discharge, mention was made of electrolysis—an electrochemical process—this emphasizes that the deterioration of insulation is seldom the result of a single process.

Although the impregnant and paper of a capacitor may be of high quality it is not unusual to find that failures have resulted from ionic impurities present in the made-up unit. Contamination occurs during production processes or may arise from any of the subsidiary parts of the capacitor. The bushings, packing pieces or flux used in soldering, for example, may provide ionic material, or the dielectric may deteriorate

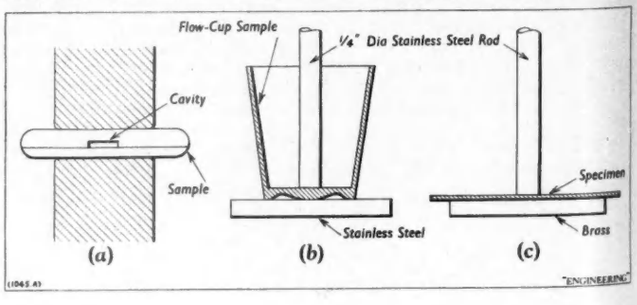


Fig. 1 Electrode arrangements for measuring discharge erosion of insulation.

Research Report

on work of the

Materials Department of The British Electrical and Allied Industries Research Association, Leatherhead, Surrey.

Head of Department

C. G. GARTON, M.I.E.E., F.Inst.P.

Deputy

H. F. CHURCH, B.Sc.

Senior Staff

V. V. DANIEL, Ph.D., F.Inst.P.
A. G. DAY, Ph.D., A.Inst.P.
Z. KRASUCKI, B.Sc.
N. PARKMAN, B.Sc.

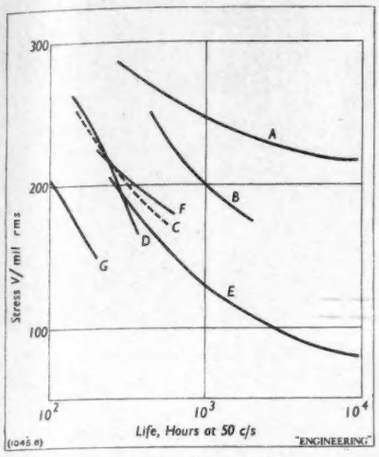


Fig. 2 The discharge resistance of some sheet materials in dry air at 20° C using rod-plane electrodes. (A) Silicone-glass fibre laminate; (B) linear polyethylene; (C) polymethyl methacrylate; (D) polyvinyl chloride; (E) epoxy-glass fibre laminate; (F) and (G) synthetic-resin-bonded paper-boards.

at high temperature. In time the ions diffuse throughout the capacitor, and may react with the dielectric; or, after migrating to the electrodes under the influence of the electric field, may react with the metal. The ensuing reactions depend upon the type of ions present; thus, hydrogen ions present in chlorinated impregnants discharge at the cathode and then combine with chlorine to produce hydrogen chloride. This reacts with the cellulose and the electrodes to produce more ions and results in local autocatalytic failure.

Ionic impurities in insulation can be detected by measuring the electrical conductivity of an extract of the insulation, made with purified trichloroethylene. This is measured in a specially designed ERA conductivity cell, Fig. 4. Experience shows what are the safe limits of contamination. The great asset of using trichloroethylene is the speed with which it will extract impurities which could take months to diffuse into a viscous impregnant. The measurement of the variation of loss-angle with applied voltage gives an estimate of the ionic content of a made-up capacitor and provides another way in which life can be predicted. In the presence of ions at low measuring voltages, the loss angle increases with voltage to a maximum. The height of this maximum is proportional to the ionic content.

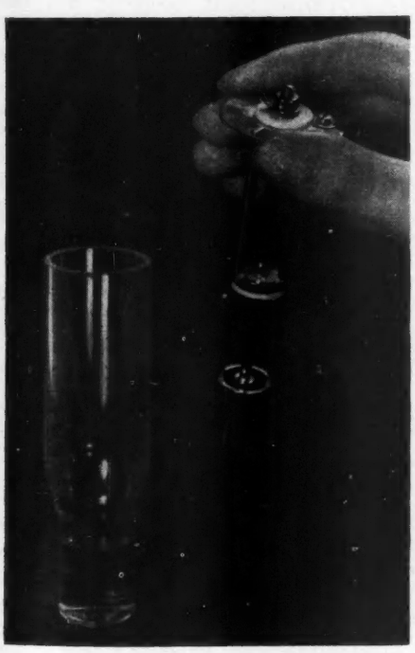


Fig. 4 The ERA conductivity cell.

Electrochemical effects are not confined to capacitors but may occur in equipment exposed to atmospheric moisture. High stability resistors of many types are subject to failures on d c load under damp conditions.[5] These resistors are frequently used at a small fraction of their maximum rating and in consequence do not get sufficiently hot to remain dry. Failures are usually the result of a simple electrolysis of the resistive element and are made possible by minute leakage currents over the damp outer insulating surface of the unit and faults in this surface coating.

Several techniques for detecting these faults have been developed at the ERA and in consequence manufacturers have been able to improve their products. Failures have occurred during damp storage, without an applied voltage; in these cases contact emf provided the potentials. At the other extreme of ambient conditions the ceramic formers of wire wound resistors working at high d c loads have caused electrochemical faults. At high temperatures, 200° C and above, sodium ions in the ceramic readily migrate to the cathode. During off-load periods the sodium combines with atmospheric moisture to make a highly alkaline and corrosive deposit, which destroys the wire. It is now accepted that ceramic formers, glazes, etc., should have less than 0·1 per cent sodium content.

If poor material is used to insulate or protect fine wire conductors, especially under d c stress, for example, in relays, ignition coils, then under damp conditions the wires are subject to electrolysis. Such failures are infrequent but are sudden and can have serious consequences. Equipment manufacturers need quality control tests to detect contaminated insulation. The ERA has investigated a test which gives a direct measure of corrosion of a copper wire[6] and has modified the original test method to increase its reliability and reproducibility between laboratories. Since once again this is an accelerated life test there are problems of interpreting results produced under very drastic conditions.

Deterioration by Heating

Economic considerations dictate that insulation shall be used at as high a temperature as possible. Unfortunately, the most important thermally controlled causes of deterioration are chemical changes, and the rate of chemical reaction increases exponentially with temperature according to the Arrhenius equation. Electrical engineers are familiar with the practical approximation to this equation, namely that for every 8 to 10° C temperature rise the life of insulation is halved.

Chemical changes, which are imperceptible at room temperature, such as oxidation, carbonization and polymerization, assume great importance at higher temperatures, and each new type of insulation presents the designer with a fresh problem. At what temperature will it remain useful for 10 to 30 years? A 10° C error in his answer could halve the life of the equipment.

Accelerated life tests must be made to evaluate the new materials, and the ERA has investigated a number of test methods to find those most suitable for evaluating one particular type of insulation—varnished fabrics.

Ideally the most suitable test is one that involves the insulation in all the hazards of temperature, vibration, chemical interaction and mechanical stress met with in service, but information gained by such a test is applicable only to one particular use, and every changed condition requires a new test result. The measurements of individual properties which were made at the laboratories, however, apply whenever the material is used, and provide a better starting point for evaluation.

A set of representative materials was heated at several temperatures for various periods, and a series of mechanical and electrical properties measured. In this way life curves could be obtained for each material. Fig. 5 shows the percentage of the tearing strength of a varnished fabric remaining after heating. By arranging the set of materials in an order of merit according to each property measured, it was possible by statistical means to find the most probable single order compatible with all the measured properties.

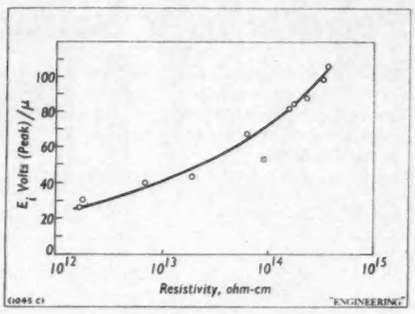


Fig. 3 The change of discharge inception voltage E_i caused by drying the paper of a rag-paper and oil system.

Measurements of tensile and tearing strength gave the nearest approximation to this most probable order and so are most likely to give a true answer in evaluating this type of insulation. This conclusion assumes that the choice of properties measured was wise and comprehensive. While measurements of single properties do not tell the whole story, wisely used they make a good foundation for more complicated and specific tests.

Accelerated life tests can predict the behaviour of materials and components but extrapolations must be justified and the rigorous conditions of the tests must not introduce hazards which are never met in service.

The research described in this article, and much else done by the Electrical Research Association has one aim—greater reliability of a vast range of electrical equipment. As our surroundings become more complex so does reliability become more important.

References

[1] Mason, J. H. *Proc. I.E.E.* Vol. 107 Part A, (December, 1960) pp. 551-568.
[2] Parkman, N. *Elec. Rev.* Vol. 165, (4th September, 1959) pp. 157-161.
[3] Mole, G. *Electrical Research Association*, Report V/T115, 1952. *and* Krasucki, Z., Church, H. F. and Garton, C. G. To be published *CEGRE Proc.*, May 1962.
[4] Krasucki, Z., Church, H. F., and Garton, C. G. *J. Electrochem. Soc.* Vol. 107, (July, 1960) pp. 598-602.
[5] Church, H. F. *Proc. I.E.E.*, Vol. 107 Part B, (July, 1960) pp. 377-385.
[6] Day, A. G. *British Plastics*, Vol. 34, (September, 1961), pp. 491-494.

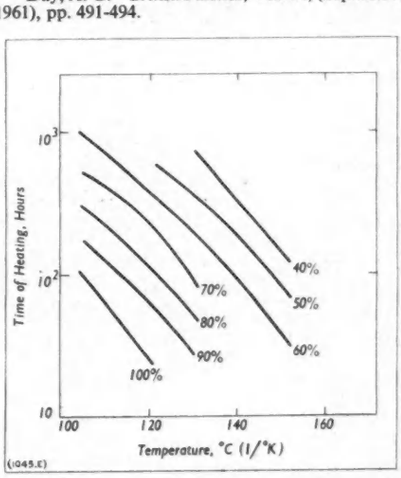


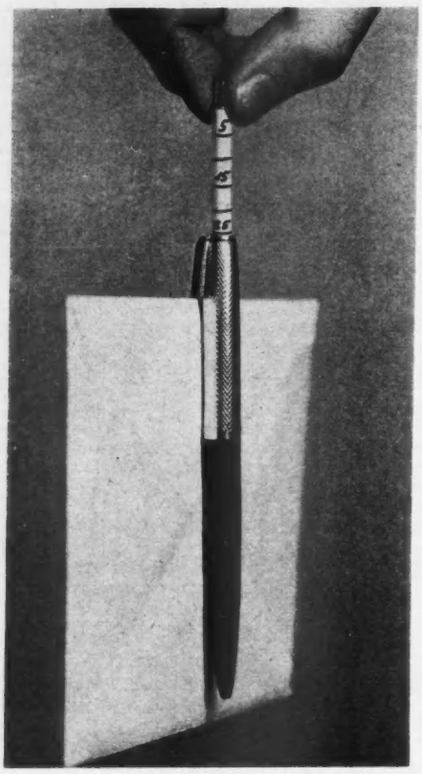
Fig. 5 The percentage of the original tearing strength of a varnished fabric remaining after heating.

Pencils and Scissors

The first illustration shows one of the many adaptations of the ubiquitous ball pen—you can now not only write your letters with it, but also weigh them afterwards to make sure they have the right postage.

The pen comes from Germany where it is made by Bass and Keller kg, Langenargen am Bodensee, West Germany, and costs DM 1·80. The basic pen itself is of quite normal design and uses a refillable ink container, reached by unscrewing the front end. Within the pen body is a spring that will take loads up to about 2 oz (50 gm). The body of the pen is left plain so that names can be printed on it for advertising and gift purposes, or just to affirm ownership.

The item to be weighed is gripped under the clip on the metal part of the casing and the whole pen suspended by the inner tube. When it hangs freely, the weight can be read off on the calibrated scale on the inner member. The calibrations are marked to allow for the weight

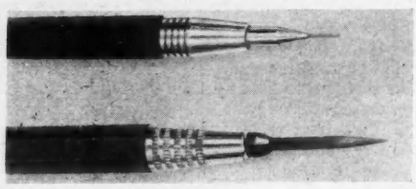


of the pen itself. It is claimed that the weighing spring maintains its initial accuracy even under conditions of constant use. Its employment is not limited to letters, for small parcels and packets can also be weighed, provided they fall within the range of the spring.

What is reputed to be the thinnest pencil lead on the market today is that shown in the illustration of the " Leroy 020 " pencil. The lead itself is 0·020 in in diameter. The great advantage claimed is that it wears down evenly and so does not need sharpening. As a result it will give even lines of consistent width throughout its life. Also it means that the user will not have to make trips to the sharpener, so interrupting his train of thought and his work. The pencils are manufactured by the Keuffel and Esser Company, of Third and Adams Streets, Hoboken, New Jersey, USA. They are supplied with a dispenser containing 24 leads and additional dispensers are available. The leads are gripped in a special slit collet.

For those who have a great deal of cutting out to do whether of materials or paper, the third illustration offers a labour saving solution. The tool is the Speed Snips, manufactured by the Speedway Manufacturing Company, a division of Thor Power Tool Company Limited, whose English address is 34 Victoria Street, London SW1.

The Snips are operated from the electricity mains (ac only) and have a consumption of approximately 14 watts. Control is by a spring loaded switch so that cutting takes place only while the switch is depressed. The Snips can be used in either the right or left hand according to convenience. The makers claim complete safety for the tool, even for children, and it has been approved by the Underwriters' Laboratories and also by the Canadian Standards Association.



(*above*) *The lead in the Leroy pencil (upper) is only 0·020 in diameter.*

(*left*) *After you have written your letter with the Bass and Keller ball pen, you can weigh it.*

(*below*) *Power operation makes for easy cutting with the Thor Speed Snips.*

The vibratory mechanism is enclosed in a very durable nylon case and the whole tool weighs only 6 oz. The design is planned to fit the hand and the tool measures $5\frac{5}{8}$ in long overall by $1\frac{5}{8}$ in wide and 2 in high. There is a choice of four pastel colours for the casing: princess pink; Venetian green; cameo beige; or Riviera blue.

Materials that can be cut include cloth fabrics, dress goods, drapery materials, and suitings. It is claimed that the plated high carbon steel blades, which are precision ground, stay sharp over long periods of hard use. The great advantage of the Snips is, of course, that which applies to most power tools, namely, that the labour and consequent fatigue of the operation is reduced, with the result that the amount that can be cut without loss of accuracy is greatly increased as also is the amount cut during any given working period. Power operation also suggests that there would be a major saving in effort when heavy materials are involved.

ENGINEERING

Published every Friday by Engineering Ltd., at 36 Bedford Street, London WC2, England.
Telephone: Temple Bar 3663.
Telegrams: Engineering Lesquare London.

Chairman
J. A. Dixon, M.A., A.M.I.Mech.E.

Editor
F. B. Roberts, M.B.E., M.I.Mech.E.

Deputy Editors
D. Fisher, Ph.D., B.Sc., A.M.I.C.E., A.M.I.Mech.E.
A. A. H. Scott, B.Sc., A.M.I.Mech.E.

Department Editors
Book Reviews and At Home
A. A. H. Scott (Deputy Editor)
Construction
D. Fisher (Deputy Editor)
Design
J. T. Godfrey
Companies and Events in Advance
J. E. Dodsworth
Marketing and Automobile Review
J. L. Tosen
Metals and Materials
D. C. E. Gribble, B.Sc.
New Plant and Equipment
C. R. H. Simpson
Product Profile
K. M. Brown
Production and Human Element
G. T. Page, M.A.
Research
R. A. Coffee, D.I.C., A.M.Brit.I.R.E.
Special Articles
P. B. Jones

SUBSCRIPTION MANAGER
G. A. Roberts

ADVERTISEMENT MANAGER
G. H. Dixon, M.A.

Contributed Articles
Notes for the guidance of contributors are available from the Editor. Contributed articles usually carry the author's name when published; they should be exclusive to ENGINEERING. When an article is accepted for publication the author is normally advised of the planned publication date.

Subscription Rates
One year, inland and abroad £5 10*s* (Canada, £5 5*s*). Three months 27*s* 6*d* all countries. Single copies 2*s* 7*d* post paid.

Back Numbers
Back numbers, from recent issues to certain of the earliest issues from 1866, are available at the usual price for single copies.

Reprints
Reprints of articles which have been published in ENGINEERING can be supplied. Requests for quotations, stating the quantity required, should be addressed to the Reprints Department.

Engineering Information Service
Assistance is available from Engineering Information Service in obtaining information, and in locating sources of information, both technical and commercial. EIS deals, for example, with names of makers and suppliers of plant and equipment, technical data on design, markets for engineering products, and the compilation of references to information on specific topics. Inquiries should be addressed to Engineering Information Service, 36 Bedford Street, London WC2.

Advertisement Rates
The rates for advertising in the classified advertisement sections (Appointments, Company Meetings, Trade and Technical) are given in those sections. The Rate Card, covering all advertisements including display, is available from the Advertisement Manager.